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Second Class-Book
OF
PHYSICAL GEOGRAPHY.

ORGANIC LIFE.

50.1600.*

BY

WILLIAM RHIND.

Price One Shilling and Threepence.

2011 f. 56

2011 f. 56

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EXPLANATION

OF

THE MAP OF THE RACES OF MAN.

The numbers, 1, 2, 3, 4, 5, and different shadings, indicate, respectively, the local positions of the Caucasian, Mongolian, Ethiopian, American, and Malay races. *a a* point out the Semitic race, both in Syria, Arabia, and in North Africa, Abyssinia and Nubia; *b* is the Circassian, Georgian, and Persian; *c* the Afghans and Hindoos, forming the Indian varieties of the Caucasian Race; *d d* is the Mexican, Brazilian, Peruvian mixed races of Spaniards and American Indians; *e* is the Papuan-Negro races of New Guinea, New Hebrides, New Caledonia; *f* is the Finns and Lapps; *g* the Ugrians, &c.; *h* Esquimaux, all allied to the Mongolian race.

The perpendicular section shows the extreme elevations at which the habitations of man are found in various parts of the world. Korokorum, a pass in Tibet, elevation, 18,000 feet. Garoo Gartop, a village of Tibet, lat. 31° N.; long. 80° E.; elevation, 16,000 feet. City of Potosi, South America, 13,330 feet; Quito, 9543; Mexico city, 7570; Hospital of Great St. Bernard, in the European Alps, 8110; Madrid, city, 1944; Wanlockhead Village, Scotland, 1380 feet—the highest inhabited locality in Britain.

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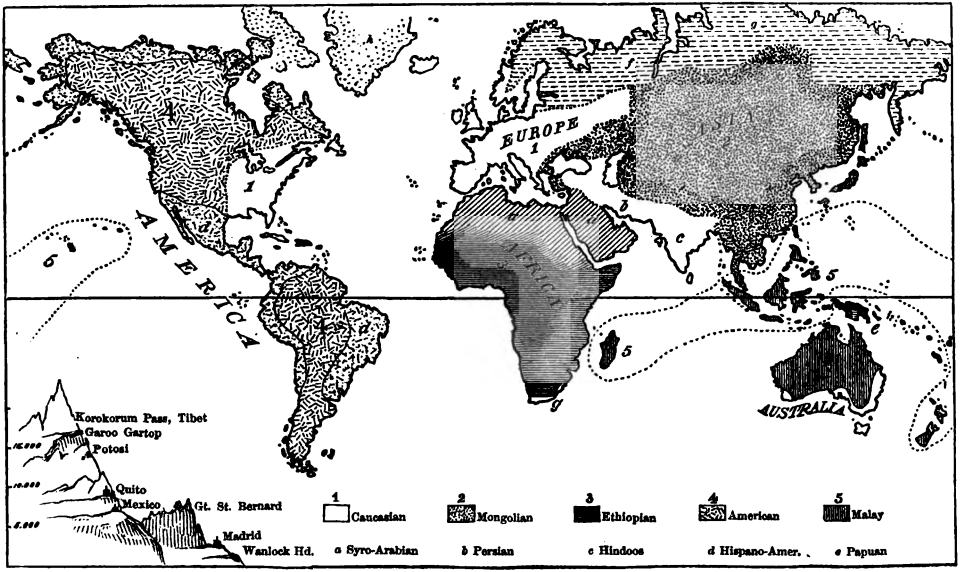
MAP OF THE RACES OF MAN.



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SECOND CLASS-BOOK

OF

PHYSICAL GEOGRAPHY:

EMBRACING

ORGANIC LIFE,

AND THE

GEOGRAPHICAL DISTRIBUTION OF PLANTS, ANIMALS, AND MAN.

BY

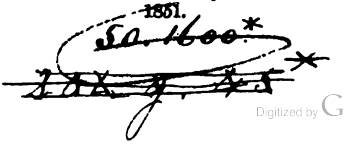
WILLIAM RHIND,

AUTHOR OF "FIRST CLASS-BOOK OF PHYSICAL GEOGRAPHY," "ELEMENTS OF ZOOLOGY," "GEOLOGY," ETC.

EDINBURGH: SUTHERLAND AND KNOX.

LONDON: SIMPKIN, MARSHALL AND CO.

1851.



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CRITICAL NOTICES OF FIRST CLASS-BOOK.

"We commend this work as carrying out the new and engaging method of teaching Geography; it has also the special merit of being carefully adapted to the purposes of class teaching. We have no doubt that books of this description are rapidly taking the place of works on Geography too long in use in our Schools. Mr Rhind states his conviction, that pupils of ten years of age are capable to appreciate the subjects so admirably arranged in this little book; if so, Schoolmasters and Parents are negligent who withheld these improvements in school literature from their children. We include parents in this censure, because we know how often the teacher has to contend with obstacles from that quarter in the introduction of new books."—*Educational Times.*

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THE first portion of this Class-Book treats of the structure and properties of organic bodies, as it is necessary first to know something of the nature of plants and animals—their relations to each other and to the soil and atmosphere—before the laws of their distribution can be properly understood.

The second portion takes up the Geographical Distribution of Plants, Animals, and Man, and forms a continuation in advance of the more elementary principles of the First Class-Book.

In classes where it may suit the convenience of teachers, this first portion may be taught either before or after going over the First Class-Book.

While there is nothing here introduced but what experience has proved can be readily understood and appreciated by pupils generally, the chief object has been—to form a connected and systematic work suited to mental training; and to endeavour to raise the tone of instruction from the mere superficialities, or at best collections of isolated facts, which too frequently characterise "works for beginners;"—as if such elementary works should be something totally different from, instead of the actual outlines of, those sciences which the reading and experience of after years are to fill up and mature.

It has been remarked by an eminent living philosopher, "that few people have an adequate idea of the amount of knowledge that can be instilled at school." Fortunately the narrow and contracted views of school education are fast passing away, and a more enlarged and liberal system of study, suited to the requirements of the age, is now almost universally adopted.

The FIRST and SECOND CLASS-BOOKS form, together, an Elementary System of Natural Science.

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LIST OF BOOKS.

The following books will assist the teacher and student in farther prosecuting the various subjects here treated of:—

Francis' British Botanist; and Botanical Terms (Elementary).
Lindley's School Botany.
Withering's British Flora.
Hooker's British Flora.
Loudon's Encyclopedia of Plants.
Landsborough's British Sea-weeds.
Harvey's Manual of Marine Algæ.
Knight's Library—Vegetable Substances Used as the Food of Man.
———— The Menageries.
———— Pictorial Museum, 4to, containing Numerous Figures of Animals.
Paterson's Introduction to Zoology for Schools.
Cuvier's Animal Kingdom. Translated by M'Murtie.
———— Engraved Tables, Illustrative of Zoology. Paris.
Carpenter's Physiology.
Johnston's British Zoophytes.
———— Introduction to Conchology.
British Zoology. By Jones, Bell, E. Forbes, Yarrel, &c.
Prichard's Natural History of Man.
Hamilton Smith's do.
Latham's Varieties of Man.
The Botanical and Zoological Parts of Johnston's Physical Atlas.
Brown's Taxidermist's Manual for Preserving and Preparing Specimens of Zoology, &c.

As many good drawings and specimens of animals and plants should be exhibited to pupils as possible; and every opportunity should be taken of calling attention to living objects of nature.

A collection of minerals, plants, birds and other animals, should have a place in every liberal establishment for the tuition of youth.

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CONTENTS

Page

SECTION I.

Form and Composition of Organic Bodies, - - - - 9

SECTION II.

Conditions Necessary for Life, - - - - - - 11

SECTION III.

Structure of Organic Bodies, - - - - - - 14

SECTION IV.

Structure of Plants, - - - - - - - 17

SECTION V.

Animal Structure—Digestion and Respiration, - - - 23

SECTION VI.

Organs of Motion, - - - - - - - 31

SECTION VII.

Organs of Sensation, - - - - - - - 33

SECTION VIII.

Natural Divisions of the Animal Kingdom, - - - - 38

SECTION IX.

Geographical Distribution of Plants, - - - - - 41

SECTION X.

Plants Useful to Man, - - - - - - - 47

Digitized by Google

Page

SECTION XI.

Geographical Distribution of Animals, - - - - 54

SECTION XII.

Geographical Distribution of Mammalia, - - - - 57

SECTION XIII.

Geographical Distribution of Birds, Reptiles, Fishes, and Insects, - 68

SECTION XIV.

he Races of Man, - - - - - - - 76

SECTION XV.

The Caucasian Race and its Sub-Races, - - - - 80

SECTION XVI.

The Geographical Distribution of the Races of Man, - - - 85

SECTION XVII.

The Classification of Animals, - - - - - - 90

Table of Classification, - - - - - - - 2

Glossary, - - - - - - - 94

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PHYSICAL GEOGRAPHY.

ORGANIC LIFE.

SECTION I.—FORM AND COMPOSITION OF ORGANIC BODIES.

THERE are two distinct states in which bodies exist on the earth, *inorganic and organic.*

Rocks, minerals, water, and air, are inorganic matters.

Plants and animals are called organised bodies, because they have a structure made up of cells, tubes, and membranes, with distinct organs, as root, leaves, heart, stomach.

If you take a mineral substance, a piece of rock or crystal, and break it into minute parts, each part is complete in itself, and is the same in every respect but size with the body from which it was broken; but if you divide an organised being thus, every part differs from the other, as the root, stem, leaf of a plant; or the head, arms, heart, stomach of an animal.

Inorganic bodies are governed by mechanical and chemical laws.

Illustrated by a stone falling to the earth by gravity, the attraction of a needle to the magnet, the expansion of air by heat, and the solution of salt in water.

Organic bodies are endowed with vital powers, which are superior to, in so far as they control, the mechanical and chemical laws of matter.

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Thus a plant or animal lives and grows by its vital powers. When these cease, it is said to die, and then its substance is acted upon by chemical and mechanical agencies, and it moulders into earthy inorganic matter.

A plant shoots its stem upwards, contrary to the laws of gravity, and animals stand and move by their own muscular powers. The vital powers resist putrefaction.

The bodies of plants and animals are formed out of a few earthy substances, water, and air.

These simple substances enter into the composition of organic beings in the following order of predominance:—Carbon, oxygen, hydrogen, nitrogen, potassium, calcium, phosphorus, silicon, sulphur, sodium, magnesium, chlorine, iron, fluorine, aluminum, bromine, iodine.

The vital actions of plants and animals, however, in conjunction with chemical processes, produce new combinations of these elements.

Plants produce sugar, starch, gum, gluten, albumen, caseine, oil, woody fibre.

Animals produce flesh, which consists of albumen and gluten, and gelatine or jelly, fat, serum.

Wheat-flour yields starch and gluten; the sugar-cane and maple-tree, sugar; the fir-tree, oil of turpentine; the cinnamon-tree, oil of cinnamon. Lint-seed and rape-seed, common oil. The skins, hoofs, and horns of animals yield gelatine or glue; the muscles or fleshy parts, gluten and albumen. The white of eggs is nearly a pure albumen. Sulphur imparts a flavour to mustard, cresses, and other herbs. Phosphorus abounds in fish and shell-fish. Iron gives the red colour to blood. Silex or flint forms the outer crust of the bamboo cane, and of wheat and oat stalks; calcium or lime, the hard parts of bones and shells. Potash is found in the ashes of burnt land-plants; soda in kelp, the ashes of sea-weeds.

The simplest structure of a plant or animal is that of a series of minute cells, communicating with each other, and forming a net-work through which circulates a fluid.

In this fluid are seen minute globules of a round or oval shape, with a dark spot or nucleus in the centre.

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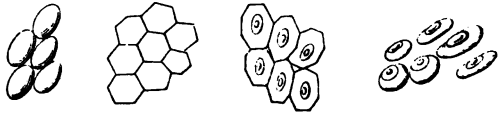
The blood of animals is composed of these very minute cells or globules; and they are seen in the juices of plants.

1.



a *b* *c* *e*

a, simple oval cells of plants; *b*, the same cells adhering together, and by pressure assuming a six-sided form; *c*, vegetable cells with central nuclei; *d*, circular cells of the human blood; *e*, oval cells of the lower animals.

By the joining together of numbers of these globules, a cellular net-work is first formed, and out of this the tubes of plants and the blood-vessels of animals; and finally the whole structure and organs of the living being.

SECTION II.—CONDITIONS NECESSARY FOR LIFE.

Bodies possessing an organised structure, when acted upon by certain stimuli, begin to exhibit LIFE.

The agents necessary for bringing out or stimulating into action the vital powers of plants and animals are—Water, food, air, heat, and light.

The three first, water, food, and air, are taken in by the living body, and enter into its substance. The solar heat and light are indispensable stimulants to vital action.

WATER, or a certain degree of fluidity, is a necessary condition of life; for as all organised bodies are made up of cells, and tubes, and vessels, a free circulation of the various juices throughout this structure is necessary.

A seed of any plant, as a grain of common wheat or barley, contains an organised germ, which remains apparently dead or inactive as long as it is kept in a perfectly dry state, but whenever this seed is put into the ground, and the necessary stimuli

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of moisture, heat, and air, are applied, it immediately springs into living action, shooting out leaves to the surface, and spreading its roots into the ground.

Many of the smallest animals or animalcules, may thus be dried on a piece of glass, and after months may be revived by a drop of water.

The wheat-worm (*Vibrio tritici*), found in grains of wheat, remains in a dry and inactive state all winter; but when the grain is sown in the ground in spring, the worm revives and ascends through the porous and juicy stem, to be in process of time again lodged in the grains of the developed ear of corn. If the grain is kept in a dry state, the animal will retain its vitality for five or six years.

The common cheese-mite may be glued to a piece of glass, and thus remain inactive for months, but when put on a bit of moist cheese, it immediately revives.

Eels and other fishes are frequently frozen in rivers, but revive on the thawing of the ice.

The larger animals have a solid body, with many hollow vessels branching through their substance, and containing fluids; but many of the simpler animals, as the *medusæ*, have bodies composed almost entirely of a thin watery jelly.

Some plants are soft and full of juices; others have a portion of their cells hardened and condensed into wood.

The divided stalk of a mushroom, or any succulent plant, viewed through a microscope, will show this; as also a thin slice of a bamboo cane, or the stem of any kind of tree cut across. (Figs. 10 and 11.)

Air is essential to the life of all organised bodies. Plants absorb carbonic acid from the atmosphere; and oxygen or vital air is taken in by all animals, by organs varying in the different classes.

This air is directly incorporated into their blood and nutritive juices, and is of such importance to the support of life, that in a great proportion of animals its deprivation for even a few seconds proves fatal to existence.

Food of some kind or another is essential to all organic beings. It constitutes the elementary matters of which their bodies are composed, and a periodical supply of it is necessary for their growth and repair.

Plants, during their torpid state in winter, require no fresh supply

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of food, and certain animals can remain for weeks and months without nourishment; but all organic beings in whom life is active, require a constant supply of food.

The land tortoise will fast for several months. Some serpents feed only at intervals of two or three weeks. Insects in the pupa state remain six months without food; and so do bears, hedgehogs, and other hybernating quadrupeds.

HEAT, or a certain temperature of the earth and air, is an essential condition of life.

Vegetation ceases in plants when the cold is at or below the freezing point of water; and at this point a great proportion of the lower animals become torpid—as insects, snails, worms, and many reptiles. The higher animals, as quadrupeds and birds, can resist for a time great extremes of cold; but a medium temperature, for at least one-half of the year, is necessary for the continued existence even of those.

Cold-blooded animals (mollusks, fishes, and many reptiles) possess a temperature very little elevated above the water in which they live.

Hot-blooded animals (birds and quadrupeds) can generate and maintain a heat in their bodies varying from 90° to 120° of the thermometer.*

Thus a mouse, a hare, or a sheep will remain for many hours below frozen snow, and yet keep up its usual animal heat; while a hot stone or iron ball, placed in the same situation, rapidly cools by parting with its heat to surrounding objects.

A temperature of from 60° to 80° is that most favourable for the vigorous life both of plants and animals.

Hence life is more abundant in the equatorial and temperate than in the frigid zones.

LIGHT is a necessary stimulus to healthy vitality.

Along with light must also be included the other undefined agencies of the solar beams—as *actinism*, electricity, &c.

Plants that vegetate in the dark are sickly, and devoid of colour, and never arrive at maturity.

* Fahrenheit's thermometer is meant throughout. See *First Class-Book*, p. 80.

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Animals seem no less generally influenced by light. To its agency they owe their colour, the full exercise of vision, and, in a great degree, the robust vigour of their bodies.

Minnows confined in a dark place become pale and colourless. Intestinal animals are white and blanched-like. The inmates of dark streets and cellars, and of the sombre manufactories of cities, are pale and sickly-looking—perhaps as much owing to their deprivation of light as of the pure air and healthful exercise of the country.

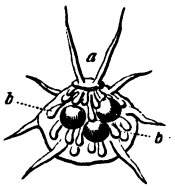
SECT. III.—STRUCTURE OF ORGANIC BODIES.

Animal and vegetable being commences in such minute forms, as not to be visible to the unassisted eye. Minute vegetable fungi grow up in fluids, and thousands of animalcules exist in a single drop of water.

The blue mould on old bread, when viewed by the microscope, is found to consist of a number of mushroom-like stalks, with a round seed-bag on the top of each. The mould on a slice of apple or pear exhibits a moss-like plant, with seed-vessels on the summit.

An infusion of hay in a little water, or of a sprig of mignonette, will, after a few days, in summer, exhibit a filmy scum on the top, a little of which, when viewed through the microscope, will show numerous animalcules.

2.



3.

Polygastric (many-stomached) animalcules, greatly magnified.

2. Volvox.
a, Tentacula; *b b*, Stomachs.

3. Leucophrys.
a, Mouth; *b b*, Stomachs.

Many plants and animals have a very simple structure. A few cells joined together form a plant, or a small bag or little mass of jelly, containing a single cavity or stomach, constitutes an animal.

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In their simplest forms, plants and animals very nearly resemble each other.

4.

Hydatid,
Cysticercus cellulosæ.

5.

Duck-weed, *Lemna gibba*, magnified.

The *Hydatid* is an animal, consisting simply of a sack or stomach, with a long neck and mouth, *a*, with two little hooks, by which it adheres to the soft parts of other larger animals.

The *Lemna gibba*, or duck-weed, is a vegetable seen frequently, in green seed-like clusters, floating on the surface of fresh water. It consists of a cellular body or frond, with rootlets and spongioles, *b*.

The various coralline zoophytes have an arborescent appearance very similar to vegetables.

6

Sertularia nigra.

7.

Laomeda gelatinosa.
a, Natural size; *b*, a portion magnified.

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The *hydra*, or fresh-water polype, found attached to leaves and reeds in slow running streams, has a small jelly-like body, with a mouth surrounded by seven or eight arms or *tentacula*, with which it seizes its food. The marine polypes, which construct coral houses, are of a similar nature.

These animals may be cut into several pieces, like some plants, and each slip will soon become a distinct being. They also propagate their young by shooting out slips or buds from the parent body.

8.

Water polype, *Hydra viridis*, magnified.
a, A young polype budding from the parent.

As the scale of being ascends, however, plants and animals diverge more and more from a common form.

Between an oak and a lion there is no external resemblance.

Both in plants and animals there are great differences of structure in the various orders and classes.

The number of distinct species of organised beings existing on the earth is very great.

Of plants known and described, there are not less than 100,000 species.

Of plants that formerly existed, but which are now nowhere found but in a fossil state, there are about 1,800 ascertained species.

Of existing animals, there are not less than 120,000 species known; and of extinct fossil animals, perhaps an equal number may have lived.

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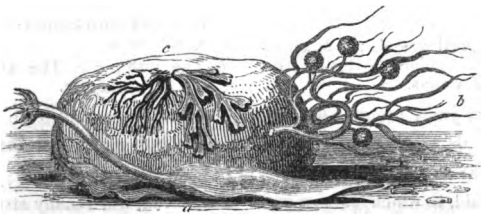
When we consider that many of these tribes are very prolific—some species, especially among insects and fishes, producing many millions in one season—the actual amount of animal life existing at one time on the face of the earth must be immense. We cannot turn our eyes to any part of nature that is not teeming with life; the earth, the ocean, and the air, swarm with their respective myriads.

SECT. IV.—STRUCTURE OF PLANTS.

The form of plants varies very much, from the simplest lichen or moss plant up to the large branching tree.

The gray or yellowish lichen, which is seen encrusting rocks, consists of a thin circular frond or leaf only. It is produced at first from a small germ or seed, carried along by the wind, and which fixes on the rock by its glutinous under side. It here vegetates, and other germs spring out and flourish around it, till at length a circular spot of lichen is produced. These lichens, decaying, crumble into dust, and, along with particles of the mouldering rock, form a soil fit for the growth of other larger plants.

9.



Marine Plants.

a, Sea-tang (*Laminaria digitata*); *b*, Gulf-weed (*Sargassum*); *c*, Fustellaria.

Marine plants (*Algæ* and *Fuci*) are very simple in their forms, consisting either of a single leaf or frond, or of a stem with ramified leaves.

Some Fuci are furnished with hollow air-bags, by which they float near the surface of the ocean, as the *sargassum* or gulf-weed, found in great abundance in the Atlantic and Pacific Oceans (fig. *b*).

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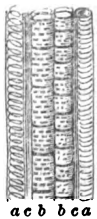
The higher orders of plants are furnished with roots, stem, leaves, and flowers.

The roots, which are porous and cellular, sink into the ground by numerous fibres (*spongioles*), and absorb moisture from the soil.

The roots also serve for fixing the plant to one spot in the soil, for the great majority of plants are stationary. The lemna (Fig. *5*) floats in water, and some parasitical plants hang suspended from trees, and absorb moisture from the air.

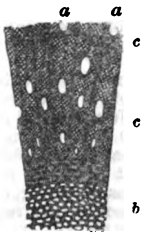
10.



A bundle of plant-cells and vessels.

a a, Spiral vessels; *b b*, Punctured cellular vessels; *c c*, Medullary rays.

11.



A cross section of a piece of oak, showing the net-work of cells and porous inter-cellular spaces *a, a.*

b, The pith; *c c*, The annular layers.

This juice mounts up through the numerous minute tubes and cells of the stem and branches, and circulates through the leaves.

A fluid, in which gum or sugar is dissolved, will readily attract a lighter fluid, as water, and draw it up, even through a thin membrane. This is termed *endosmose* (inward impulse), and is the chief cause of the ascent of sap. The exhalation or escape of one fluid, by the pressure of another flowing in, is called *exosmose* (outward impulse). These two movements are constantly taking place during the growth of plants.

Leaves are also full of cells, and on their upper and under sides are numerous small openings, through which air and moisture are freely taken in and exhaled, the leaves performing a somewhat similar office as the lungs of animals.

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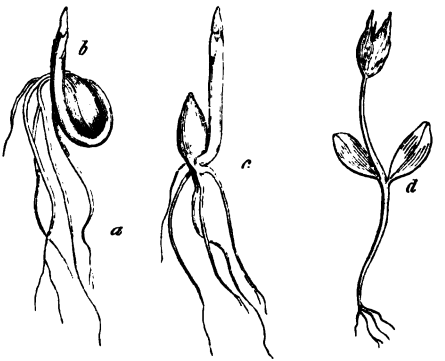
A green matter (*chlorophyle*) pervades the leaves and the soft parts of the stem under the outer bark.

When a dry seed of wheat or barley is put into the ground, it very soon begins to germinate. Stimulated by heat, moisture, and air, the cells of the seed begin to swell out, and the vital powers of the germ are aroused.

From one end of the seed several small rootlets make their appearance, and strike downwards into the earth; while, from the same end, a minute *gemmule* or rudiment of leaves turns upwards into the air.

It is a remarkable and beautiful provision in all such seeds, that, whichever way the seed may have fallen into the ground, the root invariably strikes downwards into the soil, and the leaf as regularly mounts upwards.

12.



a, Is a seed of barley which I planted with the germinating end upwards. The rootlets are seen to take a downward direction; and the gemmule, or leaf-bud, *b*, to twist up; *c* is a seed planted with the germinating end downwards.

In a field of wheat or barley, the chances are, that one-half of the seeds fall with the germinating ends down; and, did

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not the leaf-bud irresistibly turn upwards, it would be smothered, and perish.

The plant-germ forms only a very small portion of the seed. The remainder is called the *cotyledon*, or seed-lobe, and consists of gluten, starch, and sugar, which supply the young plant with food till the roots are large enough to seek nourishment from the soil.

In the common bean and pea, and many other plants, the seed is divided into two cotyledons. These cotyledons, in the ash and oak, and other trees, come up as two primary leaves, and in this way afford nourishment to the young plant. (Fig. 12, *d*.)

Cress-seeds will germinate on a piece of moist flannel tied over a cup, and will thus grow till they have exhausted all the nutriment of the cotyledons; but after this their growth ceases, as the roots are deprived of the nutritious matter of the soil.

By their roots plants take up, from the soil, water, ammonia, potash, soda, lime, silex, sulphur, phosphorus; by their leaves, they absorb carbonic acid gas and watery vapour from the atmosphere. (Sect. I., p. 9.)

By chemical and vital processes within the cells of the plant, these substances are converted into starch, sugar, oils, gluten, gum, woody fibre.

Plants during the day, and stimulated by sunshine, absorb carbonic acid from the atmosphere, and give out oxygen; during the night and darkness, they exhale carbonic acid.

Animals continually inhale oxygen, and give out carbonic acid; so that, as regards the composition of the atmosphere, the one process compensates the other. (Sect. V., p. 27.)

The process of vegetation is the grand medium by which inorganic matter is converted into food fit for animals.

No animal can convert mineral or inorganic matter into nourishment; so that all animals either directly or indirectly feed on vegetable products.

The carnivorous lion feeds on the deer and sheep; and the

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eagle, on the hare and partridge; but these again have derived their flesh and substance from the plants and herbage of the field.

In looking, then, on the green fields of grass and waving corn, it is highly interesting to think that, day after day, millions of millions of tubes and cells are busy at work manufacturing the air and water, and the products of the crumbling soil, into nourishment for man and animals.

The most nutritious parts of vegetables are their seeds, as the grains (*cerealia*), pulses, nuts; the bulbs of some roots, as potatoes, onions; and, next to them, the pulps or fruits surrounding seeds, as grapes, apples, peaches.

Plants are propagated by slips, roots, germs or spores, and seeds.

A small branch cut off a willow, and put into the ground, will shoot out roots, and become in time a distinct plant.

The bulbous appendages of some plants, as lilies, onions, potatoes, when put into the ground, produce a new plant; or a bud or rootlet of many other kinds will generally send out a stem and leaves.

Cryptogamic plants, as ferns, mosses, lichens, have no conspicuous flowers, but produce a minute germ or *spore*,—sometimes on the back of the leaf, as in ferns, or in little cups, as in the mosses; which germ, dropping into the ground, springs up a plant like the parent.

Phanerogamic, or true flowering plants, have conspicuous blossoms.

The lowest part of the flower connected with the stem is the *calyx* or cup, of the same green colour as the leaves; but it is not always present.

The *corolla* is the coloured part of the flower, and may be either of one piece, as in the common blue-bell, or divided into four, five, or more *petals*.

Within the corolla are placed the organs of fructification. The *stamens* consist of slender *filaments*, supporting on the top the *anther*, which contains a yellow powder, the *pollen*

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or fertilising dust. These stamens vary in number from one to twelve or more. In the centre is the *pistil*, its *style* supporting a round body, the *stigma*, on the top, which receives the pollen dust; and below is the *ovary*, where the seeds are formed. Sometimes the seeds are contained in pods, as in the pea, or surrounded by a pulp, as in the cherry and currant; these coverings are called the *pericarps*.

13.

Blossoms of the wild cherry.

a a, Calyx or cup; *c*, Corolla divided into five petals; *S*, Stamens; *P*, Pistil; *o*, Ovary or seed-vessel; *f*, Fruit surrounded by Pericarp, *g*.

For classification, &c., see List of Works on Botany, p. 4.

The vegetable kingdom consists of three divisions of plants, distinguished by their peculiar characters:—

I. CRYPTOGAMIC plants, without conspicuous flowers, and

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with simple germ-like seeds, without *cotyledons*, as algæ, lichens, mosses, ferns.

II. ENDOGENOUS *monocotyledons*, with one seed-lobe, as lilies, grasses, grains, palms, sugar-cane.

III. EXOGENOUS *dicotyledons*, with two or more seed-lobes, as oaks, elms, the bean, and numerous herbs and trees.

Endogenous stems increase by shooting up from within; exogenous stems increase by a layer of new woody matter under the bark, which encircles the older formed; and hence, on examining a cross section of a pine-tree or oak, a regular succession of *annular layers* or rings will be perceived, their number corresponding to the number of years the tree has lived.

The duration of plants varies very much. *Annuals* live only one season; *biennials* two years; *perennials* several years. The oak will endure for 500 years and upwards. The olive is a very long-lived tree. A chestnut-tree on Mount Etna is supposed to be 1000 years old; and the great dragon tree at Teneriffe 3000 years old.

Plants are in general very productive. A single capsule of the white poppy contains 8000 seeds; the vanilla 10,000. A single plant of elecampane will produce 3000 seeds; the great cat's-tail 10,000; the tobacco-plant 360,000; a stalk of spleenwort a million of seeds.

SECTION V.—ANIMAL STRUCTURE—DIGESTION AND RESPIRATION.

Animals have a more curiously complicated structure than plants. They have not only organs for nourishment and growth, but also organs of motion and organs of sense, by which they become acquainted with the external world around them.

Viewing the animal body as a machine, it has not only a most perfect mechanism, but unlike all human machinery, it possesses within itself its own power and volition, supplies its

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own waste, repairs or renews its damaged structure, generates its own heat, enlarges its dimensions, and moreover produces from its substance other new forms of a similar structure with itself.

Animal life, however, may be manifested by a very simple structure.

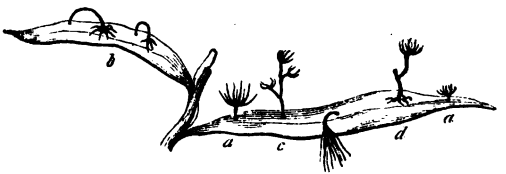
A small jelly-like mass, with a hollow in the centre for a stomach, and a few filaments arranged round the mouth or opening into this hollow, forms the whole structure of the *Hydra* or water polype.

This animal attaches its body to reeds or leaves in the water, and may be seen stretching out its arms to entangle small insects or worms. It will swallow a piece of worm, rapidly digest the juices, and then void the indigestible parts by its mouth.

The body may be cut into several slips, and each slip becomes a distinct animal. It sends out buds or germs from its body, and these drop off and become new existences.

It has the power of locomotion by bending down its body into a semicircle, and supporting itself on one end, while it draws its tail towards the mouth.

14.



Fresh-water Polypes (*Hydra vulgaris*), natural size.

a a, usual position and size of the animal; *b*, polypes in the act of locomotion; *c*, several young buds springing from a parent polype; *d*, two full-grown polypes joined together. (See also magnified polype, Fig. 8.)

The *sertularia*, *tubipora*, and many other plant-like animals, are equally simple in their forms. (Figs. 6, 7.)

The higher classes of animals possess a nervous system,

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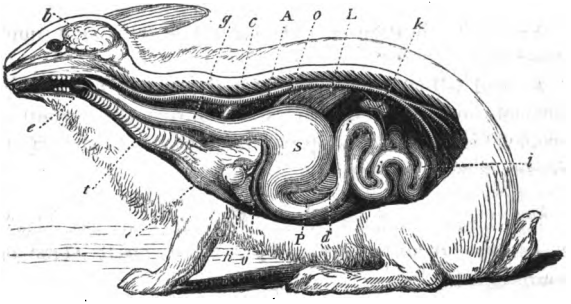
stomach, heart, lungs, the general arrangement of which will be seen in the following section:—

15.



General View of the Internal Structure of the Rabbit.

b, brain; *c*, spinal cord, the nervous filaments seen branching out on each side; *S*, stomach; *g*, gullet opening into the throat; *i i*, intestines; *t*, trachea or windpipe; *e*, epiglottis, a valve which closes the orifice of the windpipe every time the act of swallowing is performed; *L*, lungs; *h*, heart; *A*, aorta or principal artery; *k*, left kidney; *L*, liver; *p*, pancreas, its duct, and also the bile duct from the liver are seen entering the intestines at *p*; *o o*, the diaphragm, a powerful muscle which separates the stomach from the lungs and assists in the act of breathing.

All animals have a stomach of some kind or other. The hydra, we have seen, has simply a hollow in the centre of its body, but the stomach is generally an oval sac. The hydatid is an animal consisting simply of a stomach and mouth (Fig. 4).

Into the stomach the food is received after it has been masticated in the mouth.

Vertebrated animals are furnished with teeth for masticating their food. These teeth are of three kinds—*incisors*, front cutting teeth; *canine*, side tusks; *molars*, grinders or back teeth. In flesh-feeding animals all the teeth, including the grinders, are sharp pointed. In gramenivorous animals the teeth are less pointed, and the molars are round and flat on the surface.

In the stomach the food is acted upon by the *gastric juice*

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a clear, somewhat acid, fluid poured out from the inner membrane of the stomach, by which the food is dissolved or digested into a whitish fluid called *chyme*.

This chyme then passes into the intestines, where it is mixed with bile from the liver, when it assumes a thick milky appearance, and is called *chyle*.

The chyle is next taken up by a series of minute vessels, opening into the intestines, called *lacteals* (milk vessels), and from them conveyed by one large duct into the blood-vessels, where, after passing through the lungs and combining with oxygen, it is finally converted into red blood.

This blood, circulated by means of the heart and blood-vessels throughout the body, affords to every part its proper nourishment.

The blood contains all the elements of the animal frame, and gives off to the bones lime; to the muscles, albumen; to the skin, gelatine; to the liver, carbon.

In flesh-feeding animals the stomach is a single organ; in ruminating quadrupeds there are four stomachs—the first or largest is for containing the half-masticated grass; the second and third for assisting in rumination, or bringing up and re-chewing the food; the fourth for digesting the food.

The 1st stomach is called *Venter* or paunch; 2d, *Reticulum*, honey-comb; 3d, *Omasum*, moniplies; 4th, *Rede*.

Grain-feeding birds have a *crop* or preparatory stomach, and a gizzard, in which are always a few sharp-pointed pebbles, to serve as teeth in grinding down the softened seeds.

The lungs are situated on each side of the chest, with the heart in the centre, a little inclined to the left side.

The heart is a strong, hollow, muscular body, single in some animals, but double in others, with two sides, and two cavities in each side.

Connected with the left side are the *arteries*, which carry out red blood to all parts of the body. Connected with the right side are *veins*, which taking up the red blood from the

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minute extremities of the arteries, return this blood, now changed to a dark purple colour, to the heart.

From the right side of the heart the dark venous blood is sent, by repeated contractions of the cavity, into the lungs. Here the air inspired into the lungs from the mouth passes over the minute blood-vessels, the oxygen of the air is taken up by the blood, and the carbonic acid contained in the blood is given out; the consequence is, that the dark venous blood instantly becomes of a bright scarlet colour.

From the lungs the now purified blood is carried back to the left side of the heart, from whence it circulates into all parts of the body.

16.

This diagram will simplify the explanation of the double circulation. The right side of the heart, with its accompanying venous vessels, is of a dark colour; the left side, containing the arterial system, is white. *a* is the vein, carrying the blood into the right *auricle, b*. From this cavity it is propelled into the right *ventricle, c*; and from thence by the pulmonary vessel, *d*, it is made to circulate through the lungs. The vessels *e* return the purified and now florid blood from the lungs, into the left auricle, *f*; from thence it is sent into the left ventricle, *g*, and from this cavity it is propelled into the aorta, *h*, whose branches and continuations spread over the whole body, till joining the venous system, it returns again to the heart.

An ordinary microscope will exhibit the circulation of the blood in the vessels of the web of the frog's foot, or in the tail of the minnow, or other small fish. Here may be perceived the spherical globules of the blood changing their forms as they pass through the minute vessels of the tissue.

The process of breathing, then, which all the higher animals perform constantly from ten to twenty times every minute of their lives, consists in taking in a portion of atmospheric air into the lungs, which air, after undergoing certain changes, is again expired.

Ten cubic feet of air are taken into the lungs by a man every minute. In fifty years he inspires 166 tons of air, consumes

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eighteen tons of oxygen, and discharges nineteen tons of carbonic acid, containing five and a half tons of carbon, or eighty times his own weight.

The *pulsation* or sudden contraction of the heart, which takes place in all the higher animals from 40 to 120 times in a minute, promotes the circulation of the blood; in the first instance, through the lungs, and in the second place, throughout all parts of the body.

These processes cannot be suspended even during sleep, and are essential to the life of the animal; so that the heart unceasingly pulsates throughout a long life, from the first moment of birth to the last pang of death.

By respiration, and the change which takes place on the blood, a certain degree of animal heat is generated and kept up throughout every part of the body. (Sect. II.)

Pure air, both in our dwellings and out of doors—complete ventilation, to get rid of the carbonic acid gas expired, and which is fatal to animal life,—as well as due bodily exercise, to promote the play of the lungs, and, consequently, to increase the production of animal heat, are all essential for the healthy existence of man and animals.

Fishes have gills instead of lungs, and may be said to breathe water, which always contains some air, instead of pure air itself.

The gills are the red comb-like bodies placed below the gill-cover (*operculum*) on each side of the throat.

17.

Mollusks, as the oyster and muscle, have gills surrounding the stomach, with a heart in the centre.

The Cuttle-fish (*Octopus*) has the following organs:—

a, The tentacula surrounding the head; *b*, The stomach and intestinal canal, terminating at *c*; the dotted body is the liver; *d*, The heart and branchiæ.

Insects have not a heart or lungs, but have, instead of these, a *dorsal vessel*, which runs along their body, commu-

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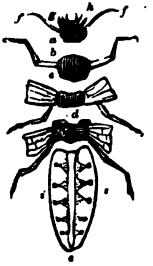
nicating with which, on each side, are spiracles or tubes, opening by a series of holes outside the abdomen; through these air s taken into the blood.

These little holes may be seen on the common caterpillar, or on the abdomen of the locust, &c.

18.



a, The head; *b*, Proto-thorax; *c*, Meso-thorax; *d*, Meta-thorax; the three joined forming the chest, under which three legs are inserted on each side; *e*, dorsal vessel, a substitute for heart and arteries; *i i*, Stigmata, or breathing-holes, communicating by spiracles with the dorsal vessel; *f f*, Antennæ, or organs of touch; *g*, Mandibles, or jaws; *h*, Palpi, or lips.

The crab and lobster have their soft fan-like gills outside, on the under part of their bodies.

19.

The Lobster.

a, Stomach, in the centre terminating in intestine, surrounded by the liver, the dotted portion; *b*, The heart, and *c*, arteries, situated near the back, and communicating with the branchiæ which lie under the tail, *f*; *d*, A knotted chain or ganglion, forming the nervous system; *e*, Antennæ, organs of touch. The eyes are placed near the base of each antenna.

Animals of a still lower grade absorb air through their porous skins, and have no system of circulating organs.

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Part of the food taken into the stomach goes to the supply of the continual waste which is taking place by muscular exercise and perspiration from the skin and lungs.

The other part of the food goes to support the production of animal heat by a process somewhat similar to slow combustion in the lungs and blood-vessels.

Food which yields gluten and albumen, as flesh, milk, bread, pulses, &c., is conducive to the nourishment of the various parts of the body; that which yields carbon, as sugar, starch, fat, oils, is conducive to animal heat. A man consumes fourteen ounces of carbon by respiration, and loses two to three pounds of matter by perspiration and muscular waste, every twenty-four hours. (*See also page* 27).

It is thus apparent that the animal system is a vortex, which is continually taking in matter from without; assimilating this matter into its substance; expending this again by muscular exertion, respiration, &c.; and then throwing it out, to take in new supplies. The body retains the same form and shape, and yet it is continually changing the particles of which it is, as a whole, composed.

Plants, to a certain extent, undergo the same changes and renovations; but trees retain the woody part of their mass permanently for centuries.

One to two seasons is the shortest term of life of the more perfect animals (for the ephemera-fly of a day has lived two years as a worm); from ten to twenty years is the average term. "Three score and ten" is the allotted age of man; and some other animals, as far as ascertained, live out a century.

Were it not for the ceaseless activity of animal and vegetable life, the inorganic world would remain comparatively still and inert. Mechanical forces would no doubt be at work in the air and ocean, and volcanic action in the bowels of the earth; but the play of chemical actions—the incessant processes of decay and renovation—would be wanting, as well as all those living motions, and sights, and sounds, which cheer and enliven the surface of our teeming earth.

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SECTION VI.—ORGANS OF MOTION.

Besides the organs for the nourishment of the body, there are others necessary for its movements, for procuring food, for defence, and in the larger animals bones, for the support of the soft parts.

The soft and tender bodies of the lower animals are protected and supported by crustaceous and horny coverings, or by shells, scales, or tough skins.

The *Terebella conchilega*, a soft worm which burrows in the sand of the sea-shore, covers its outer skin with particles of shells and small pebbles, which adhere by means of a mucilaginous fluid poured out from the skin.

The *Caddis worms*, or larvæ of the brown May-fly, which spend the first stage of their life in the shallow waters of rivers, collect round their soft bodies pieces of straws, bark of trees, or small empty shells, and thus form a strong sheath for their protection.

The *Hermit-crab*, part of whose body is tender and unprotected, takes possession of any empty shell which it may find on the sea-beach, and uses it for a house.

The shelly cases of the crab and lobster, and the horny wings and plates of insects, are, in place of a skeleton, outside their bodies, and serve for their protection, and as fixed points for the movements of their muscles.

The higher animals have an internal skeleton, or framework of bones, over which are placed their muscles and tendons.

Bones are composed of phosphate and carbonate of lime and gelatine.

The series of jointed *vertebræ*, which compose the long column of the spine or back-bone, is the most conspicuous part of the skeleton, and is common to fishes, reptiles, birds, quadrupeds, and man, all which are called *vertebrated* animals.

There is a marked resemblance in the general form of the skeleton of all the *vertebrata*, which will be obvious by placing the skeletons of fishes, birds, and quadrupeds beside each other, and comparing them.

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Muscles are the soft, fleshy, elastic, fibrous parts, known as the red flesh of animals or the white of fishes. By their contraction and relaxation motion is produced in the limbs and bodies of animals.

Tendons are tough whitish unelastic cords attached to the ends of muscles, by which these are fixed to the bones and parts which they are intended to move.

The tendons are seen and felt at the wrists, and on the back of the hand, where they go to be inserted into the bones of the fingers. By the nice balancing of the muscles and their continual exertion, man is enabled to maintain an erect position, contrary to the laws of gravity, and the inferior animals to stand and assume their various positions.

Creeping, walking, leaping, flying, swimming, are all modes of locomotion dependent on muscular power.

Fat or oil, contained in the cellular membranes, fills up the interstices of the muscular system, and renders the external aspect of the body smooth and symmetrical. By its absorption into the system, it affords nourishment during the occasional fasts of animals, their hybernating periods, and states of inactivity.

The *Skin* is a membrane common to, and characteristic of, all organised bodies, the bark of plants being similar to the skin of animals.

There are two layers of skin—an outer membrane without vessels, called *cuticle* or *scarf-skin*; an inner, or *cutis*, full of minute blood-vessels and nerves, forming raised papillæ like the down of velvet.

The outer protecting skin is insensible, the inner is highly sensitive, and is the seat of the sense of touch.

The insensibility of the outer skin, constantly exposed to abrasion and injury, is a no less wise provision of the Deity, than is the extreme sensibility of the inner skin which serves as a guardian for the protection of the vital parts beneath.

The outer skin of animals is more or less clothed with hairs, bristles, down, or feathers; in cold climates, with fur and wool;—all which, being imperfect conductors of heat, preserve the temperature of the body.

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SECTION VII.—ORGANS OF SENSATION.

The nervous system is the seat of sensation, by means of which animals become acquainted with the external world around them, and through the medium of which instinct and reason are manifested.

Simple organic life does not seem to require the agency of a nervous system, at least this system is not visibly developed in plants or the lower zoophytes. It is very early developed, however, in the progressive scale of animal existence. In the embryo of all the more perfect animals, this system is the first to become visible as a distinct structure, and branches of nerves or ganglions, go to supply all the organs of nutrition, as well as those of sense and voluntary motion. Indeed, nervous filaments of some kind or another pervade every part of the body.

Plants differ entirely from even the lowest animals, in exhibiting a total want of all true sensitive powers.

The shrinking of the leaflets of the sensitive plant, the contractions of the fly-trap, and the twisting of the fibrils of the hop plant, all depend upon mechanical processes quite different from the voluntary motions of animals.

All animals choose or reject food according to their tastes or instincts—shrink from pain, and are susceptible of pleasure, and when they please *will* motion or rest. Plants absorb alike their proper nutrition or any deleterious juices that may be presented to their roots. They feel neither pain nor pleasure, and their motions are merely mechanical, and not the result of will.

The nervous system consists of *ganglions* or knots of nervous matter and fibres, and of *brain, spinal cord*, and *nerves*.

The inferior animals are furnished with *ganglions* only—the higher animals have, in addition, a brain and nerves.

The brain consists of two parts,—an upper brain, *cerebrum*, and a lower, *cerebellum*, to which the spinal cord is attached. From the spinal cord proceed, in pairs, on each side, the nerves of sensation and motion. (See Fig. 15, *b*, *c*).

The nervous matter is of two kinds, a grayish soft, pulpy substance, and a white fibrous matter.

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In the polype and other gelatinous zoophytes, no distinct nervous system is visible, but it is probable nervous matter may be diffused among the granular bodies which form their structure.

The nervous filaments proceeding from the brain and spinal cord possess different properties. There are nerves which influence motion, nerves of general sensation, nerves of the vital organs, and nerves which regulate each particular sense.

Thus when a hot body comes in contact with the hand, the sensation of painful heat is rapidly conveyed along a particular nerve to the nervous centre, then an impulse of the will directs another nerve, a nerve of motion, to contract the muscles of the arm, by which the hand is snatched from the offending object.

In all voluntary actions some motive first influences the will, then the will calls into action the nervous system, and muscular motion or action follows.

By means of the organs of sense, animals become acquainted with the forms and other properties of bodies around them.

The sensations conveyed to the mind are those impressions which external matter makes on the nerves of special sense through the respective organs. We do not, however, always know things as they actually are in nature, but as they seem to be. A fixed star, the sun of some other system, appears to us no larger than a pin-head—a green mountain at a distance appears blue—a piece of wood which feels perfectly smooth and compact to the finger, when better known by the microscope, is discovered to be a net-work of holes and inequalities—an odour which is pleasing to a dog, is disgusting to a man.

The general properties of bodies are form, flavour, odour, elasticity, colour, hence the five corresponding senses of touch, taste, smell, hearing, seeing, are in accordance with these properties of external things.

In order to obtain a complete knowledge of the general properties of any object, every one of the senses is requisite. Thus the sight of an apple at a little distance conveys to us only the idea of a circular body with a surface of varied colours. Touch informs us that this apple is a sphere, not a flat circle, with a certain degree of smoothness or roughness on the surface. From the sound produced by striking it we may ascertain whether this sphere be hollow or solid within. Smell gives us the peculiar odour; and taste another of its important properties.

The Sense of Touch resides in the nervous papillæ of the cutis or inner skin, and is diffused more or less over all the

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body. The tips of the fingers in man, the parts about the mouth and lips in quadrupeds, and the antennæ of insects, are more particularly the seat of touch.

The Sense of Taste is confined to the edges, the tip, and slightly to the back part of the tongue.

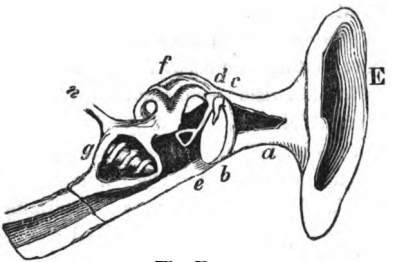
Bodies are called sapid that impart the sensation of taste, as salt, sugar, and they must be partly moist before the sensation is experienced. Hence one use of saliva to moisten the food.

The Organ of Smell is the inner membrane of the nose. Odorous bodies continually emit from their substance extremely minute particles, which, inhaled with the air into the nostril, impart the sensation of smell.

Smell is peculiarly acute in the dog and canine family generally, as also in most animals of prey.

The Ear is the Organ of Hearing; and is so formed as to receive and transmit the undulations of the air.

20



The Ear.

E, the external ear, trumpet-shaped; *a*, the passage to the internal ear; *b*, the membrane of the tympanum; *c*, *d*, the small bones of the tympanum for stretching or relaxing this membrane; *f*, the semicircular canals; *g*, the cavity of the cochlea, —both these contain a fluid, and are intended to prolong and conduct the vibrations of the tympanum to the auditory nerve, seen at *n*; *h*, the Eustachian tube, leading to the upper part of the mouth, and which admits air to the inner ear, and thus allows the free vibration of the tympanum.

When any elastic body is made to vibrate, as the string of a musical instrument, or when a concussion is given to the

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air by the report of a gun, these undulations are conveyed to the ear, and cause a vibration of the tympanum or drum. This motion is prolonged in the inner cells of the ear, and transmitted, by means of the nerve of hearing, to the brain.

The plunging of a stone into a calm lake, and the successive circles of waves in the water, proceeding till they reach the shore, will serve to illustrate the undulations in the atmosphere causing sound.

Sound travels at the rate of 1,120 feet in a second.

As light is seen almost instantaneously, the flash of a gun, or of lightening, at the distance of a mile, will be seen four seconds of time before the report reaches the ear.

Though the air is the chief medium of sound, yet water, wood, and the earth's surface, are better conductors of it.

Hearing is very acute in animals of prey, but many of the lower animals are destitute of this organ.

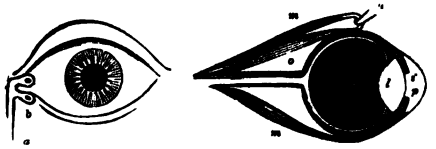
The Sense of Sight is the most varied and splendid of the whole, and is so extensive in its scope as to be bounded only by the material universe.

While the other senses are confined to objects which come into immediate contact with us, or which exert their influence at a short distance, vision acquaints us not only with the minutest atoms which float in a drop of fluid, but also with the forms and motions of other worlds and other suns, which lie far beyond us, in the space of the universe.

The eyeball is of a spherical form, and is situated in a hollow socket formed by the bones of the head and face.

21.

Fig. 1. Fig. 2.



A front view of the eye—Fig. 1—shows two circles. The outer one *i*, is the *iris* or moveable curtain, which contracts or ex-

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pands according as a bright or dull light falls on the eye, and thus it serves to regulate the admission of light into the inner chamber, the entrance to which is the middle circle or *pupil* of the eye. *b b* are the *lachrymal points*, through which the tears which serve to keep the surface of the eye moist, pass down by the duct *a* into the nose.

Fig 2 is a side view of the orbit. *m m* are muscles which move the eye-ball; *n* is a loop over which the tendon of the upper muscle doubles, and moves as on a pulley to save room; *c* is the *cornea*, or transparent fore-chamber of the eye; *i* is the iris; *l* is the *crystalline lens*, a body which refracts the rays of light entering the eye, so as that these rays meet in a focus on the inner chamber or *retina*; *o* is the *optic nerve*, or nerve of vision, which, coming from the brain, spreads out upon the retina or membrane of the inner chamber. The front chamber of the eye is filled with a transparent *aqueous* humour, the lens is composed of numerous laminæ of transparent albumen, and the inner chamber is filled with the *crystalline* humour, which is also transparent, but of a denser nature than the humour of the outer chamber. The eye thus becomes what is called by opticians *achromatic* (transmitting light without colour).

The explanation of the mode of vision is this:—Light falling in direct rays from the sun is reflected from the surface of bodies, and thus comes to the eye in straight lines from every point of an object. The front chamber of the eye first collects these rays, then they pass through the lens and are refracted or bent into a point or focus on the retina, or back part of the eye, where a minute but perfect image of the object is painted. The impression of this object is then taken up by the optic nerve and conveyed to the brain. The object is painted in a reversed position, the same as in a telescope, but, nevertheless, to the mind all objects appear in their natural positions.

The eye then is in structure like a telescope or camera. It collects the rays of light reflected from objects, and paints a little picture of the scene or object before us, which is conveyed by the nerve of vision to the brain and mind.

In many animals vision is very acute, as in the eagle, vulture, hawk. The lion, cat, and lynx, have an oblong pupil instead of a circular, and can see best in the twilight.

Many of the lower animals have no organ of vision, as the oyster, muscle, star-fish. All the known vertebrated animals

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have eyes, except the rat-mole (*Spalax typhus*), a reptile (*Proteus anguineus*) which lives in the subterranean lakes of Illyria, and a fish (*Amblyopsis spelæus*) in the waters of a dark cave in Kentucky.

Besides the senses, animals are endowed with innate or instinctive powers, by which they perform all those operations necessary for their limited sphere of existence, as nest-building, care of their young, migration, and the procuring of suitable food. These acts they perform in the fittest and most direct manner, without instruction, experience, or forethought. They are perfect from the very first, and cannot, beyond a very limited degree, be extended in the individual, while they admit of no progression or improvement in succeeding generations of the species. Animals possess also emotions or passions, nearly allied to those of man; and in the higher animals, a certain power of reasoning within the immediate range of their senses.

SECTION VIII.—THE NATURAL DIVISIONS OF THE ANIMAL KINGDOM.

There are four great divisions of the animal kingdom, according to a gradation of structure. Beginning with the simplest forms, there are—

DIVISION I.

ZOOPHYTA and RADIATA, simple animals having a plant-like form, as the *Hydra*, *Sertularia*, *Sponge*; and animals having a radiated structure of nervous cords, as the *star-fish*, *sea-urchin*; all more or less aquatic animals, with few indications of instinct, and with senses of touch and taste only.

DIVISION II.

ARTICULATA or JOINTED, with a body formed of several segments jointed together, as *insects*, *spiders*, *crabs*. Most of these animals undergo a metamorphosis or change of form, in

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the course of their development. They have three or four, if not the five senses, and are highly endowed with instincts.

DIVISION III.

MOLLUSCA, SOFT FLESHY animals, furnished with a heart, stomach, and gills, and frequently covered by a shell, as the *oyster, muscle, snail.* Except the nutritive, the other organs are defective, and their instincts are few. Touch and taste are commonly their only senses, though several have vision, as the cuttle-fish and snail.

DIVISION IV.

VERTEBRATA, animals possessing a vertebral column, or chain of back-bones, and a more or less complete skeleton or internal frame, with a brain, nervous system, and the five senses. Subdivided into *Mammalia, Birds, Reptiles, Fishes.* Instinct highly developed—reason in man.

Animals are farther distinguished into *Classes, Orders, Genera,* and *Species.*

For explanations and table, see pages 90-92.

Every animal derives its origin from a parent of the same kind; and thus every animal produces its young "after its kind," for there is in nature a continued and distinct preservation of families and species.

The lower zoophytes produce their young by buds or offshoots from any part of their bodies, in a somewhat similar way as many plants. They also produce ova or eggs.

The young of the medusæ assume various forms as they pass through successive stages of growth.

Insects produce in the first instance eggs. From these eggs are hatched a little worm or *larva.* These larvæ live and feed for some time, and then change into a *pupa* or *chrysalis,* assuming a hard horny covering. In this state they remain for months,—many for a whole winter,—without tasting food, and in summer burst their covering, and come forth as winged insects (*imago*) exactly of the same form as their original parents.

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The common cabbage-butterfly, the silk-worm, and the willow-moth, afford familiar examples of this *metamorphosis*, or successive change of form in insects.

Fishes, at certain seasons of the year, deposit in the sands of shallow seas, their roes, which are composed of numerous minute round ova. Each of these eggs becomes a little fish. Salmon yearly leave their usual haunts, the ocean, and ascend rivers to deposit their spawn. Herrings come in myriads from the deep seas to shallow firths and bays, for the same purpose.

22.

a *b* *c* *d* *e* *f* *g* *h*

Development of Shell-Snail and Frog.

The *Physa fontinalis*, a small shell-snail common in our ditches, deposits its spawn on the leaves and stems of plants. This spawn consists of a gelatinous mass, in which are seen minute black ova. In a few days the influence of the sun and air excite these to life, and they gradually enlarge and become visible as distinct little globules, *b*, containing a fluid, and in the centre the embryo, which has now acquired a continued revolving motion. A few days more show the embryo, with its shell distinctly formed, *c*; and at last the animal, *d*, bursts its enveloping membrane and makes its escape.

The spawn of the common frog exhibits a similar progressive change of form of the embryo. The ovum is seen at *e*. After a short time it acquires a head, body, and tail, as at *f*, *g*; and bursting its enveloping membrane, becomes a tadpole, *h*. In this condition it is an aquatic animal, with gills on each side of the throat; but after a few weeks more, it acquires first one pair of legs and then another, the tail meantime disappearing by absorption, and at last it leaps ashore a perfect frog.

Birds are a higher class of oviparous animals, and the chick is produced by hatching, in a somewhat similar mode of development as above.

A hen's egg consists of an outer shell of carbonate of lime, two membranes lining the shell, and containing at the larger end a quantity of air between them—of *albumen* or *white*, which furnishes the first food of the chick—of the yolk or red part, which forms the latter food—and of the *citricula*, or germ of the future chick, which is suspended by an albuminous cord in such a way as always to float on the upturned surface of the egg, and is thus in contact with the warm body of the parent.

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At first the germ of the chick is not larger than the head of a pin. It successively acquires a brain, heart, head, and spine, legs, wings, skin, and feathers, and bursts the shell with its sharp-pointed bill on the twenty-first day of incubation.

The mammalia produce their young alive, and perfectly formed. They are suckled by milk from the teats of the mother. The young of the dog and others are at birth blind. The young of the kangaroo is produced incomplete in form, and not larger than a mouse. It is nursed in a bag or pouch of the mother till it acquires the size of a common rabbit.

Many fishes, as the herring and the cod, produce from one million to three millions of young in a season.

The *Aphis*, or green fly, so common on shrubs and juicy plants, produces, from a single parent, in one season, an almost inconceivable number of millions of offspring (one quintillion).

The lower zoophytes and animalcules increase with a most astonishing rapidity, and the myriads of them in stagnant fresh water, but especially throughout the ocean, are incalculable.

SECTION IX.—GEOGRAPHICAL DISTRIBUTION OF PLANTS.

Every region of the globe has its peculiar vegetation.

Of a class of plants, for instance, embracing several families, one family will be found in Europe, another in Asia, and a third, perhaps, in America. The species of these families may have a strong general resemblance, yet the Asiatic will be found to differ considerably from the European, and the American from both.

Some families, and even species, have a wide range over the earth; others, again, are confined exclusively to one zone, or even to a particular region of that zone.

The mosses, lichens, and simpler cryptogamic plants appear to have the widest range. Many lichens and fuci, of the same species, have been found both within the Arctic and the Antarctic circles.

The grasses and reedy plants are also very generally diffused.

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Though almost all plants are fixed to one spot of earth, yet their seeds are carried to great distances by winds, ocean currents, and rivers, and the agency of birds and other animals, as well as man.

The downy *pappus* of the thistle and dandelion seed may here be pointed out, and its floating along in the air with the seed pointing downwards; the broom-pod, which, when fully ripe, opens with a sudden spring, and scatters the seeds many yards away; birds feeding on cherries, haws, &c., and carrying the indigestible stones, and dropping them at great distances. Many troublesome British weeds have been carried to North America, along with grain, and now flourish there, to the annoyance of the farmer. The Pampas of South America are overrun with European thistles. On the other hand, the gardens and fields of Europe have been enriched with beautiful and useful plants from every region of the earth.

These are means which greatly promote the diffusion of plants over the face of the earth; yet all these will not account for their actual localisation.

We must suppose, then, that certain local centres of vegetation were primarily established on the earth, corresponding to the existing continents and large islands; as also to former continents once existing, but which, in the changes which the earth's surface is continually liable to, have now disappeared.

The arrangement or grouping of the vegetation of the earth has, in the first instance, undoubtedly a relation to climate; and thus we find a tropical, a temperate, and an arctic vegetation, as we advance from the equator to either pole; heat, light, and moisture, the principal agencies in vegetation, here exercising their influence. (Sect. II.)

But there is a grouping, according to longitude, in which the climate could have but little influence.

Thus, if we follow the isothermal line of temperature, which corresponds to 50° through Europe, Asia, and America, we shall meet with very different plants in the different regions, although the climate, and soil, and elevation of each may be very nearly the same.

No less than twenty-five groups or centres of vegetation

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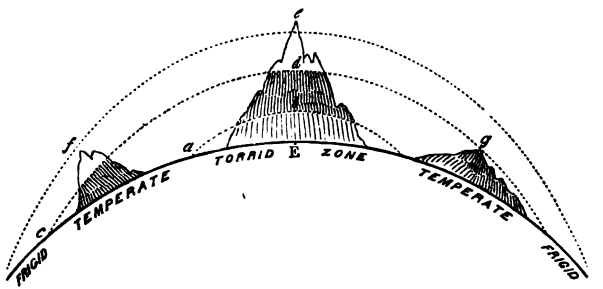
have been enumerated, each group being characterised by certain plants which predominate in it, and which, in most instances, are peculiar to it.

Thus we have a North American group, a Central American, an Indian, a Polynesian, a region of spices, of balsam trees, &c.

The *perpendicular* arrangement of vegetation, or that which arises from elevation above the level of the sea, as on high mountains and table-lands, depends upon climate exactly in a similar way as that of the equatorial and polar distribution.

We have only to call to mind that the warmest portion of the atmosphere is that nearest the earth's surface, and that, as we ascend, the air gradually becomes colder, until we reach the line of constant congelation. (*See First Class Book*, Sect. III.)

23.



This diagram represents a section of the earth's surface, with elevated mountains, near the equator, E.

If a line is drawn from the south extremity of the temperate zone, as *a b*, and another line from the north extremity, as *c d*, the space of the mountain between *b d* will form its temperate zone; while a line drawn from the pole to *e* will point out the frigid zone, the base of the mountain, *b* E, constituting its torrid zone.

As the snow-line descends gradually from the equator to the pole, it will be seen that a mountain placed towards the pole, as at *f*, will have its snow-line much nearer the earth's surface than the mountain at the equator. And a mountain, as at *g*, though of considerable altitude, may yet not reach the snow-line.

The three natural zones of climate, on each side of the Equator, have been, in respect to vegetation, divided into eight zones or regions.

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TABLE OF ZONES OF VEGETATION NORTH AND SOUTH OF THE EQUATOR.

MARKED OUT IN LATITUDE, IN TEMPERATURE, AND IN THEIR CHARACTERISTIC VEGETATION.

Zone.	Latitude. N. and S.	Temperature. Fahrenheit's Thermometer. Mean of Year.	Summer.	Characteristic Vegetation.
POLAR, . .	72° to 90°	1° to 16°	*37° to 38°	Lichens, Mosses.
ARCTIC, . .	66½° to 72°	28° to 32°		Rhododendrons, Saxifrages.
SUB-ARCTIC, .	58° to 66°	39° to 42°	60° to 68°	Pines, Birches, Beech.
COLDER TEMP.	45° to 58°	42° to 53°	56° to 68°	Oak, Elm, Ash, Apple, &c.
WARMER TEMP.	34° to 45°	53° to 62°	68° to 82°	Olive, Orange, Fig, Almond.
SUB-TROPICAL,	23½° to 34°	62° to 71°	73° to 84°	Myrtles, Laurels, Dwarf-Palm.
TROPICAL, .	15° to 23½°	73° to 78°	80° to 86°	Tree-Ferns, Palms, Sugar-cane.
EQUATORIAL, .	0° to 15°	78° to 82°		Palms, Spices.

Barley. Oats, Rye. Wheat. Vines.

Maize, Rice. Coffee, Sugar, Spices.

* The lower temperatures correspond generally to those of the New World, and chiefly in the Southern Hemisphere.

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We have thus, within from ten to twenty degrees of the north pole, vegetation commencing with the simplest lichens and moss plants; advancing southwards, shrubs, and rushes, and grasses make their appearance; still farther south, pines, birches, and junipers. Then succeed oaks, elms, and other forest trees; in more genial regions, the olive, orange, fig; and, arriving within the glowing regions of the tropics, tree-ferns and palms of large size, with fruits, spices, and sugar-canes, are found in the utmost luxuriance.

Mosses, lichens, heaths, and shrubby evergreens, as rhododendrons, junipers, characterise the polar vegetation.

Grasses, rushes, sedges, and reedy plants are more prevalent in the temperate and sub-arctic regions than in the equatorial.

Four families of plants (*compositæ*, *cruciferæ*, *labiatæ*, *umbelliferæ*), of which the daisy, the turnip, thyme, and the carrot are individual examples, are most prevalent in the temperate zone; some, as the *cruciferæ*, being scarcely known in the torrid zone.

The pea-tribe (*leguminosæ*) is common in the tropics; as also the *euphorbiaceæ*, which family contains generally acrid and poisonous juices. Ferns are common in the moist hot plains of the tropics, and decrease towards the poles. Of the *cerealia* (bread-plants), maize and rice are tropical; while wheat, oats, barley, rye, millet, have a wide range over the temperate and sub-arctic zones.

The aromatic and spice plants are chiefly found within the tropics; sugar, coffee, tea, and cotton are also tropical or sub-tropical.

Great Britain has been divided into three regions or zones of climate, according to elevation.

The *woody region* extends over three-fourths of the whole surface of Britain; in England, embracing all the south-eastern district, and a large proportion of the western—the

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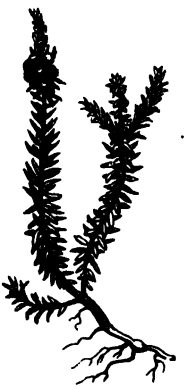
Penine chain of mountains, the Cumberland chain, and the mountainous parts of Wales being the exceptions.

The greater part of this region forms undulating plains of meadows, pasture, and corn-fields. The highest wheat-fields in the north of England do not exceed 1000 feet; in Scotland, from 800 to 1000 feet. The upland portions are covered with forest trees, fruit trees, and shrubbery.

The *barren region* succeeds to the upland, and consists chiefly of bleak swamps and heathy moors, with dwarf birch, bog myrtle, juniper, and heath plants. In the lower part, crowberry and cloudberry are amongst the few fruits; the Alpine arbutus, broom, furze, and fox-glove, the chief flowering plants. The upper part is still more barren—heath, mosses, and lichens, forming the only vegetation.

The *Alpine region* forms the summits of the highest land, and is bare and barren, and for most part of the season covered with snow.

24.



Crowberry (*Empetrum nigrum*).

This shrubby plant is one of those that mark the higher boundaries of vegetation in Britain.

25.

Dwarf-Willow, natural size (*Salix herbacea*).

The least of trees, from one to two inches in size, grows on the summit of Ben-Lomond, Scotland.

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Great Britain and Ireland appear to have possessed successive sets of plants and animals.

Thus the fossil plants found in the coal strata are now extinct. The mammoth, hyæna, gigantic stag, and other quadrupeds, whose skeletons are found in the ancient caves, and in the diluvial mud, are no longer inhabitants of the soil. The present vegetation appears to have come partly from the arctic regions of the north of Europe, partly from central Europe, and, as is demonstrated in the south of Ireland, partly from Spain and southern Europe. Our deer, foxes, and other wild animals, in all probability, also came from continental Europe, at a time when the Straits of Dover were dry land.

In almost every locality, the teacher may have an opportunity of illustrating the distribution of plants. Some species will be found growing on the tops of walls and rocks, as the mosses and lichens; others on the roofs of houses, as the *stone-crop* and *house-leek*; others, again, in ditches and swamps; while, on hills, even of moderate height, a difference will be perceived between the plants growing at the bottom and on the summits.

SECTION X.—PLANTS USEFUL TO MAN.

The grain-plants (*cerealia*, from Ceres, their supposed inventor), are the most important of vegetables to mankind.

Yet these so precious plants are nowhere now found in their wild or natural state; they are to be met only with civilised man; and it is by his culture and care that they are preserved.

Some have supposed these seeds to have been originally nothing more than grasses improved, by long cultivation, to their present state; but nowhere can even the parent grasses be found. From the earliest records, man has possessed and carried them along with him in each successive wave of population. Wheat, oats, and barley, hitherto unknown in America, or in Australia, or Polynesia, have been carried there, and now form the chief food of millions.

It is probable that the cerealia may have formed part of the vegetation of a region now entirely submerged and obliterated.

The cerealia contain in their seeds or grains the chief ma-

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terials necessary for the sustenance of animal life—gluten, starch, sugar.

It is only by the assiduous culture of the cerealia, and other allied plants, that a country can be made for any length of time to support a dense population. Savage man derives but a precarious existence from even extensive districts of country in a state of nature, and he must be continually on the move to ensure a supply of wild animals, on which he lives. In some of the islands of the eastern Archipelago and Polynesia, highly favoured by a genial climate, the natives contrive to live on farinaceous food, supplied by nature, with little or no culture; but man is there inferior in every respect to civilised man.

WHEAT (*Triticum*) was known to the Egyptians, Hebrews, and other nations of antiquity, and is now used as bread by almost all the civilised nations of the world. There are several species, especially the summer and winter wheat. It grows from lat. 23° to lat. 64° N. in Europe and Asia; in South America, at an elevation of 12,000 feet; in the Himalaya mountains even higher.

BARLEY (*Hordeum*) is a more hardy plant than wheat, and is found in Lapland in lat. 70°; in the Shetland Islands in lat. 61°; in Russia and Siberia in lat. 68°.

It does not thrive in tropical regions. It is converted into malt by heat and moisture causing its starch to change into sugar, and in this form is used for making beer and alcohol.

OATS (*Avena sativa*) are cultivated from lat. 34° N., and, in India, even from lat. 25°, as far north as lat. 65°. The oat affords a nutritious and wholesome food.

RYE (*Secale*) is cultivated in Scandinavia, as far as lat. 66° N., and in many other parts of Europe, in dry sandy soils. It forms the bread of a large portion of the population of northern Germany and France, but is now rarely raised in Great Britain.

RICE (*Oryza sativa*) is a grain extensively cultivated in south Asia, and in most tropical countries where sufficient heat and moisture exist. This grain consists almost entirely of starch, and forms the food of a greater number of human beings

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than all the other cerealia together. It is also extensively cultivated in America, Africa, and the Asiatic Archipelago.

MILLET is a diminutive grain, which is cultivated to some extent in southern Europe, and other countries, and is made into bread.

MAIZE (*Zea Mais*), or Indian corn. The true origin of this valuable plant is unknown; some reckon it a native of America. It is extensively cultivated in the New World, and also in the warmer parts of Asia and Europe. It affords a nutritious meal, fit for human food, and especially suited for fattening animals.

The POTATO (*Solanum tuberosum*) is a native of Chili, South America, and was introduced into Britain by Raleigh, in 1586. Fortunately, it is a plant of easy growth in every habitable region of the world; in all soils, and at all elevations fit for the growth of plants.

The BATATA, or sweet potato, is a native of India and China.

The YAM (*Dioscorea sativa*) is a climbing herbaceous plant, and is extensively cultivated for its root in Asia, Africa, and America.

ARROW-ROOT is the root of an herbaceous plant, a native of Africa, which yields a fine flour.

MANIOC or CASSAVA is a native of Brazil, and a highly poisonous plant; yet its root yields a pure starch, much used in making bread, and otherwise.

PALMS. Various species of the palm yield cocoa-nuts, dates, bananas, sago, all which are extensively used as food. A pure oil, and a kind of wax, are also obtained from palms.

The SUGAR-CANE (*Saccharum officinarum*) is a native of the torrid zone, but will grow in the warmer parts of the temperate zones. It is extensively cultivated in South America, the West Indies, India, and China. Cane-sugar was first introduced into the continent of Europe, from Sicily, in the fifteenth century, and has now become an article of indispensable use.

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The BREAD-FRUIT TREE (*Artocarpus incisa*), a native of the south-east of Asia and the Polynesian Islands, grows to the height of 40 feet, and bears a pulpy fruit, 9 inches in length, which is used as a substitute for bread.

TEA (*Thea*) is an ever-green shrub, about 6 feet in height, of which there are two varieties. It grows in China and Japan, from lat. 25° to 45° N. It is also found in Assam, and has been lately introduced into North India. Tea was first imported by the Dutch into Europe in 1610; now fifty-two millions of pounds of it are annually imported into Britain.

COFFEE (*Coffea Arabica*) is a native of Arabia-Felix, and is grown in the West Indian Islands, in South America, and the hottest parts of the torrid zone, at an elevation of from 1000 to 3000 feet. Coffee was first introduced into England in 1652.

CACAO (*Theobroma*) is a nut, the produce of Central America, Mexico, Guiana, and the West Indies.

PEPPER. The plants which furnish pepper grow in the tropical parts of America, and in the East India Islands.

CLOVES, and NUTMEGS, and other spices, are chiefly procured from the Molucca Islands.

CINNAMON. The cinnamon-tree, a species of laurel, attains the height of 20 feet, and grows chiefly in Ceylon and in Cochin China.

COTTON (*Gossypium*). There are three species of plant whose downy seeds yield cotton—the herbaceous, the shrub, and the tree cotton. They grow in the tropical regions of Africa, Asia, and America; from which latter place the British supply chiefly comes. This supply consists of about six hundred millions of pounds annually.

INDIGO (*Indigofera tinctoria*, &c.) Several species of leguminous plants produce this dye. It is manufactured largely in Hindostan, and in the West India Islands, Brazil, and other places.

The VINE (*Vitis vinifera*).—The grape vine grows wild on the borders of the Caspian Sea, and it has been known as a

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cultivated plant from the earliest ages. It is not known when or by whom it was introduced into Europe. The culture of the grape extends from latitude 25° to 50° N., embracing a zone of 2000 miles in breadth. The best wines are produced about the centre of this zone. The vine, introduced from Europe, thrives in the United States of America, California, south Africa, Australia. The chief wine countries in Europe are Spain, Italy, the south of Germany and France, and Greece and its islands.

The Olive Tree (*Olea Europea*).—The wild olive is found indigenous in Syria, Greece, and in Africa on the lower slopes of the Atlas mountains. The olive is cultivated in many parts of Syria, in Greece, Italy, Spain, and south of France. The young tree bears fruit in its third year, and continues to flourish for many centuries. One old olive tree in Italy is said to have yielded, in one season, 240 English quarts of oil.

The Oak (*Quercus*), is the chief of the forest, and one of the most celebrated and useful of timber trees. Its great size, massy form, long duration, and the strength of its wood, all contribute to enhance its importance. It was held sacred by the Greeks and Romans, and no less so by the ancient Gauls and Britons. Three species are indigenous to Britain. Several species extend over all the temperate parts of Europe and Asia; and at least fifty species are found in North and South America. It is found in the torrid zone only at considerable elevations. Some species of the oak are deciduous, others evergreens. Though very porous (see Fig. 11), the wood of the oak is most durable, and is much used in ship-building; the bark is employed for tanning leather; and the gall-nut is used in dying black, and is one of the ingredients of ink.

The Pine Tribe (*Coniferæ*) contains a number of families of very important trees, as the fir, spruce, larch, cypress, yew, araucaria, juniper, arbor vitæ. They are all evergreens, with

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the exception of the larch and gingo, and yield turpentine and resin, and a soft, but durable and extremely useful, wood.

The greater number of species are natives of the temperate and sub-arctic regions, as the north of Europe, Siberia, North America, southern part of South America, Himalaya Mountains, China, Australia.

The SCOTCH FIR, indigenous to Scotland, is also widely diffused in other parts of the world.

The Cedar of Lebanon is a noble tree, and must have been common in ancient times, though only a remnant now is left in Palestine.

The CHILI PINE (*Araucaria imbricata*) is a native of

26.

Chili Pine (*Araucaria imbricata*), from a young tree in the Botanic Garden, Edinburgh.

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South America, ranging from 36° to 46° south latitude. It is a noble tree, attaining a height of 150 feet. It fixes its roots among the bold rocky slopes of the Chilian Andes, and also in the moist boggy valleys, forming dense forests. It is also found to bear the winter of Britain, and thrives in sheltered situations.

The NORFOLK ISLAND PINE (*Altingia excelsa*), is another noble species found in the New Caledonia Islands of Australasia. It attains a height of upwards of 200 feet, and affords a white, tough, and excellent timber. It grows in Britain, but is more delicate than the araucaria.

The fossil pines of the coal strata and of the lias, are supposed to have been of this family.

27.

Norfolk Island Pine (*Altingia excelsa*), from a young tree in the Botanic Garden, Edinburgh.

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The MAHOGANY TREE (*Swietinea Mahogani*) is one of the largest and most majestic of trees. The trunk and branches are of great size, although the leaf is not larger than that of the elm. It is a native of Honduras and the country forming the western shores of the Caribbean Sea, as also of the West India islands. Another species is found in Central Hindostan. Mahogany was first used in this country about the beginning of last century.

The PERUVIAN BARK TREE (*Cinchona*), of which there are several species, is a native of Peru, and grows on the chain of the Andes, extending for some distance north and south of Lima. The bark of this tree yields the medicine known as *quinine*.

The MAGNOLIAS are celebrated for their size, beauty, and the splendour of their large flowers. The species are confined to eastern Asia, chiefly China, and to the south part of the United States of America. The magnolia region extends along the Atlantic coast from the north part of North Carolina to within 300 miles of New Orleans.

The Big Laurel and Tulip Tree (*Liriodendron*) are noble and beautiful trees, 70 to 100 feet in height.

SECTION XI.—GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

Animals, though possessing the power of locomotion, have yet, like vegetables, certain places on the earth's surface to which the different tribes and families are confined.

As in the case of plants, this distribution, in the first instance, depends upon climate; but, at the same time, every different region of the globe presents its peculiar forms of animals.

In the torrid zone animal life is most abundant, and it decreases gradually towards the poles. Life, too, is more energetic and prolific, and there is a greater proportion of the larger

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animals, with the exception of whales and some other marine animals of the polar regions.

Several orders of animals are entirely confined to the warmer regions, as the monkey tribe, the camel, elephant, rhinoceros, and the larger animals of prey, as the lion, tiger, hyæna.

Birds of brilliant plumage, but nearly devoid of song, reptiles of all kinds, and especially venomous ones, and numerous species of insects of large size and bright colours, also characterise the torrid regions.

The temperate zones contain a large proportion of gramenivorous quadrupeds, of birds of various kinds, and especially singing birds.

The colder regions are characterised by the deer tribes, sheep, goats, bears, wolves, foxes; by a large proportion of the web-footed waterfowl; by whales, seals, walrus, great numbers of fishes, and of the smaller marine animals.

The perpendicular distribution of animals is also in accordance with their habits regarding climate.

A high tropical mountain presents several divisions or zones of animal life, the same as those of vegetables.

Animals are found at even a greater elevation than any plants. In general, however, they must be located in the same region as the plants on which they feed.

The llama of the Andes lives at an elevation of 13,000 to 16,000 feet; the Pamir sheep of Tibet, at an elevation of 15,000 to 17,000 feet.

The condor of South America mounts to the height of 20,000 feet.

The minnow and the puga fish were found in a lake in the eastern part of Hindoo-Koosh, at an elevation of 15,000 feet.

Animals observe a certain rule of distribution in the ocean, but in a reverse order from those on land.

Animals are most numerous towards the surface of the ocean, and in shallow seas surrounded by land. Animal life decreases in proportion to the depth, and beyond 1000 to 2000 feet living beings probably cease to exist.

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Here, too, we have an illustration of the influence of light, heat, and air, on animal existence.

Many mollusks, as the limpet, muscle, whelk, cockle, live on rocks or sand near the surface, alternately left bare and covered by the tide. Others, as the oyster and ligula, lie deeper in the mud. Some, as the nautilus pompilius, can move from deep to shallow water; and several of the simpler zoophytes are found living at a considerable depth, and are ever ready to feed on the minutest particles of decomposing plants, thus carrying these particles again into the great vortex of life.

Minute animalcules pervade all the upper parts of the ocean in inconceivable myriads, rendering it luminous by their phosphoresence.

The migrations of animals, however extensive, do not interfere with their peculiar localisations. Animals migrate in order to procure food or suitable breeding places.

Migrations are generally made either from colder regions, to escape a rigorous winter, or from hot countries in order to enjoy a more temperate summer season.

Swans, geese, ducks, migrate from the cold winter of the north of Europe to the south, and return north in early summer.

Deer, buffaloes, and other American animals, migrate to the southward to escape the starvation of an arctic winter.

The rail, quail, swallow, cuckoo, and other birds, leave the dry scorching summers of the south of Europe, and fly north to Britain, where a milder season and abundance of food await them. The homes of all those migrating animals may be said to be the country in which they breed.

Migrations then generally take place in the direction of latitude, from north to south, or from south to north, more rarely in the direction of longitude.

These migrations in the case of birds are generally made in the direction of land, as little of ocean being traversed as possible.

Notwithstanding the great power of wing which many birds have, there are very rare instances of birds of one region crossing to another. Continents such as Europe and Asia, that join each other, have at the line of junction a mix-

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ture of species on either side, but this mixture has very narrow limits.

Migrating birds fly at the average rate of 50 to 60 miles an hour, or 600 to 700 miles in a day or night of twelve hours.

In the ocean fishes migrate chiefly from deep seas to shallow estuaries, for the purpose of depositing their spawn.

Thus herrings migrate in shoals from the deep seas to the shallow shores of Britain.

Salmon migrate annually from the sea, and ascend their own native rivers to spawn in the shallow streams near their sources. Having accomplished this, they again return to the sea.

These migratory instincts of animals are full of interest. Occurring at periodical times, they are most probably suggested and guided by the change of season as to heat and cold, as also by the air-currents of the atmosphere, the electric and magnetic influences, as well as by certain changes in the animals' own bodies, in relation to excess or diminution of food, and other causes. We have here an illustration of the relations subsisting between the atmosphere and animal life.

SECTION XII.—GEOGRAPHICAL DISTRIBUTION OF MAMMALIA.

The earth has been divided into five zoological kingdoms or provinces.

1. Europe, subdivided into northern, middle, and southern
2. Asia, subdivided into northern, middle, and southern.
3. Australasia, including New Zealand and Polynesia.
4. Africa, including Arabia, Madagascar, &c.
5. America, divided into arctic, northern, tropical, and South America.

Some species, and entire families of animals, are confined to one of these regions; others are found in two or more regions.

The MONKEY TRIBE (*Quadrumana, four-handed animals*) are confined to the tropical and sub-tropical regions of the

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world. They extend over the whole of Africa, India, the south part of China, and eastward to the Phillippine Islands. In America they are found from Honduras to beyond the Pampas, in Buenos Ayres.

The monkeys of the old world (*Simiæ cattarhini*) differ entirely from those of the new, in having the head, and especially the nose, nostrils, and teeth, more human-like. The American monkeys (*S. plattyrrhini*), have the nostrils placed at the side like quadrupeds, and two additional molar teeth in each jaw, making thirty-six teeth in all.

There are of the monkeys of the old world seventy-nine species; of the new world, ninety-one species. The Barbary ape, found on the rock of Gibraltar, is a singular exception of an animal of this tribe deserting its native region. It is the only species in Europe.

The orang-outang, in outward form approaches nearest to man. One species (*Simia satyrus*), is found in the Island of Borneo, in China, and Malabar—the other, the *Chimpansè*, inhabits Guinea and Congo, in Africa.

Monkeys ascend the Himalaya Mountains to the height of 13,000 feet.

Of BATS (*Chieroptera*) there exist 219 species, three-fourths of which are found in the tropics of Asia, Africa, and America. Of five species of hedgehog, two are found in Europe; of four species of mole, one is European. It is common in Britain, with the exception of the Hebrides, Orkney, and Shetland Isles, but is not found in Ireland.

The family of bats are remarkable, as possessing a thin membrane, extending from the fore to the hind feet, which enables them to fly like a bird, though they are in every other respect mammals.

They, as well as the hedgehog, pass the winter in a state of inactivity or sleep; a wise provision for their safety,—because, during that season, flies and insects, on which they feed, entirely disappear.

Moles hollow out ruts under ground, casting up the earth into mole-hills, and through these ruts they run and catch insects and grubs. They go deeper into the soil during winter.

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Of the *Flesh-feeding animals* (*Carnivora*) the FELINE family have a wide distribution over the globe, but the chief of them are confined to warm latitudes. The lion, of which there are two species, is confined to the old world. The African lion is spread over almost the whole of that continent. The Asiatic lion is confined to Persia and the jungle districts of India. The royal tiger is found only in Central Asia and the Islands of Sumatra and Java. The puma is the equivalent for the lion in America, and has an extensive range from Philadelphia in the north to Patagonia in the south. The jaguar, or American tiger, is found chiefly in Brazil and Paraguay. The wild-cat is a native of most parts of Europe, and occurs in Asia-Minor.

The DOG family (*Canis*), including the wolf, fox, jackall, dog, is extensively distributed. The two first were originally spread over almost the whole of Europe, and North America, and Asia, though the wolf is now extirpated in many districts. The wolf was extirpated from North Britain about the year 1577. A species of the dog (Dingo) is found in Australasia. Of the domestic dog there are a great many varieties, if not distinct species, as the shepherd-dog, pointer, greyhound. The dog, of all other animals, has the singular instinct of preferring the society of man to the unrestrained habits of nature, or even to the companionship of his own species. He, as well as the horse and camel, are animals that it is difficult to tell from what stocks they may have originally sprung.

The hyæna is common in south Africa and in south-western Asia.

Of the BEAR (*Ursus*) there are twelve species dispersed over Europe, Asia, and America, and one species in Abyssinia. The brown bear was once common in most parts of continental Europe.

The number of species of land carnivora amount to 514. Of these only about 200 are of the larger and more destruc-

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tive kinds—a great proportion of the others prey on insects. The larger carnivora, too, multiply very slowly. Hence, on the whole, animals of prey bear a small proportion to those defenceless animals which are preyed upon.

The MARSUPIAL, or pouched animals, are so called because the loose skin of the abdomen forms a pouch which contains the young. There are 123 known species, 27 of which belong to North and South America, and the remainder to Australasia and Java.

The GNAWERS (*Rodentia*) are distinguished by the chisel-shape of their incisor or front-cutting teeth. They have no side canine teeth. The eyes are placed laterally in the head and projecting, so that they can see both before and behind. The Order comprehends the squirrel, marmot, rat, mouse, beaver, hare, porcupine, guinea-pig, and many other species, amounting in all to 604.

The harvest-mouse is the smallest of all known quadrupeds, measuring, exclusive of the tail, only one inch in length.

The Rodentia have a wide distribution over the earth—some of the species are found in every region from the equator to the poles, and at all degrees of elevation.

The Polynesian Islands form the only exception. Rats and mice are now found there; but it is probable they were introduced from other countries. These islands are altogether remarkable in possessing no native quadruped.

The species of Rodentia in the new world appear to be of a lower grade of organisation than those of the old.

The beaver for its fur; the musk-rat as furnishing the perfume musk; the hare, rabbit, are all useful animals of this interesting family.

TOOTHLESS ANIMALS (*Edentata*), are so called because all are deficient in front teeth, and several are entirely toothless. They consist of the sloths, armadillos, ant-eaters, ornithorynchus. There are eight species found in Asia, and Africa, and Australia, and twenty in South America.

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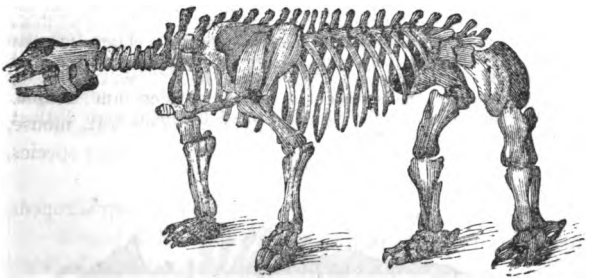
The duck-billed ornithorynchus of Australia, is a quadruped with the toothless bill of the duck, and several of the peculiarities of structure of birds.

The fossil skeletons of the *Megatherium*, *Mylodon*, and other gigantic sloths, found in South America, demonstrate that much larger animals of this family existed formerly than at present.

29.



Megatherium.

This skeleton of the megatherium was found in the alluvial clay near Buenos Ayres. Another was discovered near Lima, and a third in Paraguay. The skeleton is fourteen feet in length, exclusive of the tail, and seven feet high. The unwieldy form of the skeleton, and the great strength and massiveness of its forelegs, have suggested the idea that these animals tore down large trees, and fed on their leaves and tender branches.

The PACHYDERMATA (*Thick-skinned animals*), are so called from their tough thick skins. Their limbs have either hoofs, or have close toes approaching to hoofs. The elephant, hippopotamus, rhinoceros, tapir, peccary, hog, horse, ass, zebra, quagga, belong to this class, of which there are thirty-nine species, thirty-one of which are found in the old world, and nine in Central and South America.

The Asiatic or Indian elephant is found in Sumatra, lat.

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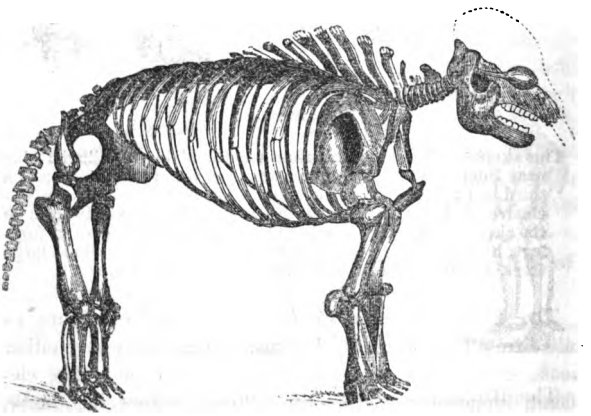
6° S., and extends through the Malay peninsula to southern China, thence to India, on both sides of the Ganges, including Ceylon, and along the Himalaya range to near 30° N. latitude.

The African elephant extends from the northern part of the Cape Colony, to the river Senegal on the west, and to Abyssinia on the east.

The elephant is said to live for 100 years.

The Asiatic species has an oblong head, the crown of the molar teeth is marked with transverse waving lines, exhibiting sections of the worn down laminæ of which the tooth is composed; the ears are comparatively small, and it has four nails on the hind feet. The African species has a round head, convex forehead, large ears, and the crowns of the molars divided into lozenges. The Mastodon and the Siberian fossil Elephant were distinct species of ancient eras.

30.



Fossil Elephant.

Fossil elephant (*Mastodon maximus*).—The bones and tusks of this animal are common in the drift clay of Europe, and entire

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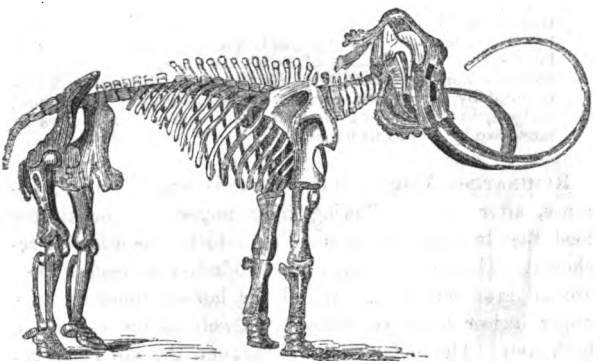
skeletons have been found at the Great Salt Lake on the Ohio, and in Virginia, United States of America. These remains are found in the mud, a few feet from the surface of the soil, and not only bones, but fleshy parts and the remains of half-digested vegetables, consisting of leaves of a shrub still growing in the country, accumulated in little heaps corresponding to the situation of the stomach, leave little doubt of their relation to the more perfectly-preserved skeletons among which they lie. A complete skeleton, in the museum of Harvard University, measures 25 feet in length, and 12 feet in height.

Siberian Elephant.

This animal was discovered in an ice-bank in Siberia, in 1799. The body had been frozen up and enveloped in a mass of clay, and in this state so completely preserved that the flesh, skin, hair, and bristles, were all entire. The skeleton is preserved in the museum of St Petersburgh. It differs from the skeleton of the living elephant in the form of the head, in the greater length and curvation of the tusks, and in the long hair by which the skin was covered.

31.



The Hippopotamus, or river horse, is found only in the rivers of Africa, from the river Gariep, on the south, to the Upper Nile in Dongola.

The Rhinoceros is an inhabitant of Asia, in which there are three species, and four in Africa, one of which, the white

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rhinoceros, with one long horn in front, is conjectured to be the *Reem* or unicorn of the Bible.

The *Hyrax Syriacus*, a small pachyderm about the size of a rabbit, is supposed to be the coney of the Bible.

The Swine (*Sus*). The wild boar is a native of Europe and Asia. Six species of the Indian swine are distributed over Malaya, the Asiatic Archipelago, and the Island of Papua, Madagascar, and eastern Africa.

The Tapir is common to South America and the Indian Archipelago.

The Horse (*Equus caballus*), one of the noblest and most useful of animals, cannot now be traced in his wild state. The members of the same family, the ass, the quagga, dziggtai, are found wild in Tartary, and extend from Siberia to Egypt. The zebra is a native of South Africa.

There are many varieties of the domestic horse, from the diminutive Shetland pony to the large London dray. The Arabian horse is the most beautiful and spirited. Millions of wild horses roam the Pampas of South America, the offspring of domestic horses, set adrift by the Spaniards. When first discovered by Europeans, the new world contained no horses; and yet, in the ancient diluvium, fossil bones of a species of horse are by no means uncommon.

Ruminating Animals (*Ruminantia*) are so called, because, after first swallowing their imperfectly masticated food, they bring it up a second time into the mouth, and rechew it. The foot is divided into two halves or hoofs. They are all gramenivorous. In all the horned ruminants the upper incisor teeth are wanting, as well as the canine, in both jaws. The molar teeth are flat, and the jaw has a rotatory motion.

The ruminants, with hollow horns, have two prominences of bone attached to the skull, called moulds, on which the true horns gradually grow, increasing, by successive rings, every year of the animal's life. The horns are albumenous, and of the same nature as hair, nails, claws. The ruminants

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are gregarious, generally swift-footed, and readily perceive the approach of enemies by their acute sense of smell.

The hollow-horned ruminants are,—the ox, musk ox, buffalo or bison, auroch, gnu, antelope and gazelle, goat, sheep.

The deer family have antlers, which grow from the heads of the males. They are not horn, but true bone, and are renewed every season, the old ones dropping off.

The camel, llama, and camelopard or giraffe, are also ruminants.

There are as yet known about 150 species of ruminants distributed over all the four continents; but none are natives of Australasia or Polynesia.

They are found at various degrees of altitude. Oxen graze on the Alps 8000 feet above the sea, and sheep still higher. Sheep and goats ascend to the snow-line in Tibet and the Himalaya Mountains.

The Camel, a patient beast of burden, and admirably fitted for crossing arid and desert plains, has been under the domestication of man from the earliest records of history. It is found in Arabia, Syria, Asia Minor, the south of Tartary, and part of India; also in the north of Africa and the Canary Islands.

The Bactrian camel, with two humps on its back, and shaggy hair, is common in Central Asia, and to the north of the Himalaya Mountains.

The Llama of South America differs from the camel, in being smaller, and having no hump on its back. It frequents the mountainous country of Peru, Chili, and Patagonia, and is to be seen in herds generally of from twelve to thirty, but sometimes amounting to several hundreds.

The Camelopard is a native of South Africa, and found nowhere else. It there roams its native plains in herds of sixteen to thirty. The male is twenty feet in height, the others from fifteen to seventeen feet.

The Deer family (*Cervus*) contains several species; as—the rein-deer, spread over the northern parts of Europe, Asia,

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and America; the fallow-deer, extending over the middle and south of Europe into Persia, China, and Abyssinia, in north-east Africa; the stag, or red-deer, common in the north of Europe, and in North Britain; the roe, the smallest of European species, found also in Asia.

Of Antelopes, the chamois is a well-known European species. About forty species are found in South Africa, and ten in Asia.

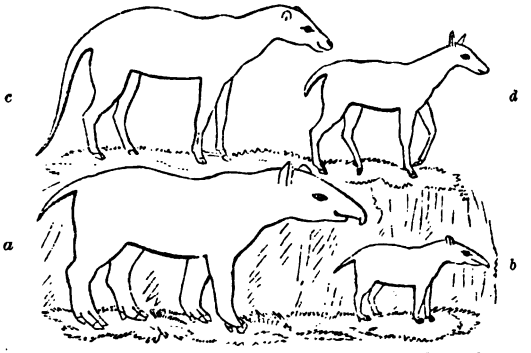
The Sheep (*Ovis*) one of the most ancient of domestic animals, may be traced originally to the mountainous countries of Western Asia. The Rocky Mountain Sheep is a native of North-West America.

The Ox (*Bos*) is found in a wild state, in great numbers, in Asia, and America, and South Africa. The species are—the buffalo, the American bison, the musk-ox; but it is still unknown to what species we owe our European domestic cattle.

To the ruminantia man owes food, milk, wool, leather, parchment, horn, glue, tallow.

In a large quarry of the Paris Basin, which contains five

32.



a, Paleotherium Magnum; *b*, Minimum; the first about the size of a horse, and resembling the living tapir; the second about the size of a hare; *c*, *d*, Anoplotherium, of different sizes, were ruminating animals, somewhat like the antelope family.

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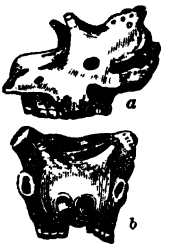
strata, of fresh water and marine formations, occurring alternately, many remains of extinct quadrupeds have been discovered. From the restored skeletons, the probable forms of some of these animals were sketched by Cuvier (Fig. 32).

Among many remains of quadrupeds found in a fossil state in the Sivalic or lower range of the Himalaya Mountains, the most remarkable is the Sivatherium, an animal partaking of the forms of the ruminant and the pachyderm. A side and front view of its head is here given. It had two pairs of horns, and, from the form of the muzzle, it was probably furnished with a flexible proboscis.

33.



Head of Sivatherium.

34.

Head of Dinotherium.

a, Side view; *b*, Front view.

The *Dinotherium* is another extraordinary extinct animal, portions of which have been found in the province of Hesse Darmstadt. From these, the structure of the animal seems to have been intermediate between the tapir and the mastodon. Others have conjectured it as having been allied to the whale. Its tusks are like the walrus, and its length probably approached eighteen feet.

WHALES (*Cetacea*), though living in the ocean, are true mammalia, and afford some of the largest species of animals in existence. They inhabit the arctic and antarctic oceans, ranging occasionally into more temperate latitudes.

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The great Greenland whale (*Balæna Mysticetus*) is 70 feet in length, and weighs 160,000 lbs.; the sperm whale (*Cachalote*) is nearly as large; the rorqual is a third species. All are sought after for their oil.

The narwhal, porpoise, and other smaller species of *Delphinidæ*, are common in the northern seas.

The Greenland seas have been greatly thinned of these animals, from repeated fishings. The South Sea affords now a more profitable fishing.

Near the antarctic circle Captain Ross met with numerous whales, whose experiences had not yet warned them to beware of the deadly harpoon.

The Seal (*Phoca*), of which there are at least a dozen species, is found in great abundance on the shores of North America, in Greenland, Spitzbergen, Behring's Straits, and in the Caspian Sea, and Aral, and Baikal lakes.

Fisheries of these animals are annually prosecuted at those localities, and at least a million of seals are caught yearly.

SECT. XIII.—GEOGRAPHICAL DISTRIBUTION OF BIRDS, REPTILES, FISHES, AND INSECTS.

BIRDS (*Aves*) are distinguished from the mammalia by their oviparous birth, by their semi-erect position, and standing on two legs, while the upper extremities are formed into wings. Their bodies are lightly made, covered with feathers, and, with a very few exceptions, adapted for flight.

The apteryx of New Holland has no wings, and the ostrich and emu only use their wings to aid them in running.

Birds are largely endowed with instincts, as illustrated in their nest-building, care of young, migrating. Their beauty of form and plumage, and the songs of many species, render this one of the most interesting of the classes of animals.

The class of birds includes at least 6000 known species;

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and they are distributed over every region of the globe, from the equator to the poles.

The equatorial regions contain, on the whole, the greatest amount of species; but Europe has more birds than any other individual region, except tropical America. Europe contains the greatest number of water-fowl; Europe and tropical America the greatest amount of birds of prey; and Asia the greatest number of gallinaceæ, of which the domestic fowl is an example.

Of Birds of Prey (*Rapaces*), the Condor of the Andes is the largest flying bird, measuring eight feet from tip to tip of the wing, and four feet from the head to the tail. It breeds in rocky elevations from 10,000 to 15,000 feet above the sea; and has been seen in its flight 22,000 feet high.

The Golden Eagle (*Aquila Chrysaëtos*) is, like the lion among quadrupeds, the king of birds; and this distinction he merits from his size, muscular form, noble and daring aspect, and from his prowess as a bird of prey.

Parrots (*Psittacidæ*), from the brilliancy of their colours, and power of imitating the human voice, are much prized birds. They extend from Carolina, United States of America, to South America and Australasia. In Asia and Africa, they are confined within the torrid zone.

Humming-birds, the smallest of the class, are almost confined to tropical America, though some species are found both in North and South America, beyond the tropics.

Birds are found at various elevations; and, though possessed of powers of extensive locomotion — some species annually migrating for thousands of miles—yet they are, on the whole, as permanent in their particular localities as other classes of animals.

Of the GALLINACEÆ,—the Pheasant is found extending over a considerable part of Central Asia, and the islands of the Asiatic Archipelago. The Peacock has a less extensive range. India is supposed to be the native country of our

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domestic fowls. The Turkey is peculiar to the central parts of North America.

As is the case with most of our domestic animals, it is uncertain from what stock we derive our common fowl. The jungle-fowl of India has been stated as the origin of the species; but this is doubtful.

The Ostrich (*Struthio*), of which there are several species, is a native of Africa, Arabia, America, Australia, and the Indian Archipelago.

The Cassowary is found in the Indian peninsula, Sumatra, Java, New Guinea, and the neighbouring islands.

The Emu is confined to South Australia, and the islands in the vicinity. It is seven feet in height.

The Eider Duck, celebrated for its soft down, and many other species of ducks and geese, are common on the shores of the Arctic Ocean.

Water-fowl are found in greatest abundance in the sub-frigid zones. The more equable temperature of the ocean, and the abundance of marine animals for food, favour this distribution. In several of the barren ice-bound islands of the antarctic seas, Captain Ross found the penguin and other aquatic birds swarming in myriads.

Bones of the Dinornis, a gigantic bird, which must have been at least ten feet high, have been found in the alluvial soil of New Zealand, and the bird must have lived there at no distant period, though no living specimens now exist. The Dodo, a bird recently common in the Mauritius, is now also extinct.

Foot-prints of gigantic birds have been found impressed on slabs of sandstone in North America, of species now entirely unknown, but supposed to belong to the class of waders. The foot-marks, indicating the ordinary walk of the largest bird, are four to six feet distant from each other. The length of the foot, including two inches of claws, is seventeen inches; so

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that the bird must have been twice the size of the largest ostrich.

35.

Ornithichnites ingens. O. giganteus. O. tetradactylus. O. palmatus.

Reptiles (*Reptilia*), are cold-blooded animals, with a less perfect organisation, and more sluggish vital movements, than the preceding classes. Some are without feet, others have two or four. Certain species live on land, others are aquatic. They are oviparous, either producing perfect eggs or spawn, which becomes vivified without the hatching or care of the parent, as frogs; or they are ovo-viviparous, producing eggs containing young already living, as serpents. There are four divisions,—tortoises, lizards, serpents, frogs, comprehending upwards of 700 species. (See Table, p. 92.)

The great proportion of reptiles are found in tropical regions, a few only of the frogs and smaller genera extending to the colder climates. The low-lying level portions of continents, the estuaries of rivers, and small flat islands, are the localities in which they are chiefly found. America contains nearly the half of the whole species; the island of Java the next greatest number.

Tortoises are distributed over the four continents; but are most numerous in the United States of America. The marsh-tortoise is found in Prussian Silesia. Turtles are generally found within the parallels of 30° N. and S.

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The hawk's-bill turtle furnishes tortoise-shell, and is caught near Cuba and Hayti, on the coasts of New Guinea, and several of the Polynesian islands.

The Crocodile is found in Africa; the Gavial, along the coasts of Asia, eastward to Australia; the Alligator or Cayman is peculiar to America.

The Chameleon, remarkable for assuming a change of tint of skin, is common in Spain and Sicily.

A Lizard (*Lacerta agilis*) extends as far north as Scotland and Ireland.

The Boa, or Rattlesnake, is confined to South America. Venomous serpents are most common in India, Java, and Australia; while in the Polynesian islands serpents are unknown.

Europe contains only two small species of the viper.

Of the Frog, America contains seventy-four species; Great Britain two species. The frog extends as far north as Finland. Ireland has the common frog, but no toads.

Of extinct reptiles, there are many remarkable species whose skeletons have been found in the lias, oolite, wealden, and newer fossiliferous strata.

The Iguanodon, an herbivorous reptile of the same family probably as the iguana lizard of the West Indies, must have equalled in size the largest whale (sixty to seventy feet).

The Icthyosaurus, or fish-lizard, appears to have had the long snout of the dolphin-whale, teeth like the crocodile, the head and breast-bone of a lizard, the vertebræ of a shark, and four paddles similar to those of the whale. The largest is thirty feet long. The orbit of the eye is ten inches in diameter.

The Plesiosaurus had a back-bone like the crocodile, with a neck longer than its whole body, the head of a lizard, the ribs of a chameleon, and the paddles of a whale. Some of these animals, of which four distinct species are known, were twenty feet in length.

The *Pterodactyle*.—Skeletons of an animal which has received this name have been discovered of so anomalous a form,

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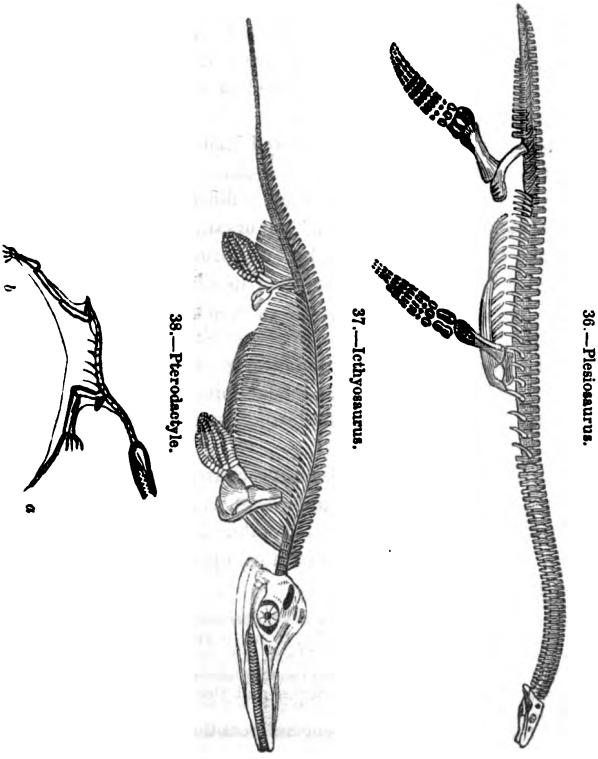
as to leave it doubtful whether the creature belonged to the class of birds, amphibious animals, or reptiles. Its structure partakes both of the reptile and bat. From the nature of the



38.—Pterodactyle. 37.—Ichthyosaurus. 36.—Plesiosaurus.

bones of the skeleton, it has been supposed to be a reptile, but it resembles the bat in so far as it must have been furnished with a thin membrane stretching from the extremity of the fore to the hind legs, which enabled it to fly through the air. (Fig. 38, *a*, *b*.)

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FISHES (*Pisces*) form the lowest class of vertebrated animals. Their element is the water, and they are furnished with fins for locomotion, and gills instead of lungs. The shape of fishes is that best adapted for gliding with least friction through the dense element of water; and all fishes that go to considerable depths are furnished with an air-bladder, which by being compressed or expanded, facilitates their perpendicular movements.

Though fishes might be supposed free to roam the whole ocean, yet their limits are as well defined as those of land animals, and every region presents a different kind.

The varying temperature of the ocean, its depth and shallowness, the nature of the bottom, proximity to land, and various other causes, influence their localisation.

Thus the cod and haddock resort to deep water; the turbot and other flat fish live chiefly in shallow sandy estuaries.

But independent of this, the various seas in different parts of the world, have their peculiar inhabitants; and even certain lakes and rivers in the same country possess species peculiar to them alone.

Of 853 species of the fishes of Europe, 444 inhabit the Mediterranean, 216 the British seas, 171 are found in the Scandinavian seas, 210 are fresh-water fishes, and 60 species of the marine fishes annually migrate up the various rivers to spawn.

Various kinds of fish furnish a wholesome and grateful article of human food. The salmon, trout, herring, have reddish coloured muscles; the cod, haddock, &c., are called white fish.

The most valuable fisheries are those of cod on the Banks of Newfoundland, the pilchard fisheries and the herring fisheries on the coasts of North Britain.

The Russians manufacture isinglass from the air-bag of the sturgeon, and *caviare* from its roe.

Fossil fishes are numerous. The *ganoid*, with angular enamelled scales, and a peculiar form of the tail, are characteristic of the older strata of the earth, and belong to species now extinct.

INSECTA.—The insect tribe affords a few species that are of economical importance to man.

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The Honey-bee (*Apis mellificus*), one of the most singular and interesting of insects that live in communities, is found dispersed over many regions of the globe. The community consists of queen-bee, drones, and neuters, or working bees. Bees collect honey from the nectaries of flowers. This honey, by digestion, is converted into wax, of which the hexagonal combs of the hive are formed. Bees also collect the *pollen* or fertilising dust, found in the anthers of plants, and with this they feed their young.

Before the introduction of sugar into Europe, honey was an article of great luxury, and the domestic culture of the bee more attended to than in the present day.

The Silk-worm (*Bombyx Mori*, the moth of the mulberry-tree), is a native of Asia ; and the Chinese were acquainted with silk many centuries before it was known in Europe, or even in the west of Asia. Some missionaries are said to have brought the eggs of the silk-worm from China to Constantinople, in the year 522. From these the cultivation of the silk-worm spread into Greece, Italy, and France. Even in the reign of Queen Elizabeth, silk garments were a great rarity in England. The cultivation of the silk-worm extends over India and the warmer parts of Europe. One moth lays 500 eggs, and the hatching of them may be aided by artificial heat where the climate is not sufficiently warm.

The Cochineal Insect is a sort of plant-louse (*Aphis*) which feeds on the *Cactus* plant, a native of Mexico. The flower of the Cactus is of a deep red colour, on which the insect feeds, and thus it becomes embued with its tint. A day or two after the blossoming of the flowers, the Indians spread cloths beneath the plant, and collect the insects, which are much prized as forming a red dye.

Gum lac, used in making varnishes, is the product of an Indian insect.

The Blistering Fly (*Meloe vesicatorius*) is a bright green beetle common in Spain.

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SECTION XIV.—THE RACES OF MAN.

MAN, (BIMANA, two-handed, *Homo sapiens* of Linnæus)—forms an order distinct from the lower animals, and of which order he is the only genus and species.

His physical structure differs from that of all other animals, in being adapted for the erect position.

For this purpose his foot is so formed that he treads directly upon its sole; his lower extremities are furnished with large and powerful muscles, and thus he is enabled to support his body in an erect position.

His head, which is large, from containing an expanded brain, is placed on the vertebral column or spine, so as to be supported in an upright position.

The arms possess extensive and free motion, and the hand is so formed and supplied with muscles as renders it fit for the most varied movements.

From the structure of his teeth and digestive organs, man seems to be allied to those animals that feed on fruits, nuts, and the roots of vegetables, but the art of cookery enables him to convert almost every substance in the animal and vegetable kingdom to his nourishment. Hence he is called an *omnivorous* feeder.

Although in muscular power, and in the acuteness of some of the senses, man is surpassed by several animals, yet on the whole he may be said to excel in the completeness of his general organisation.

He can endure long-continued exertion, extremes of climate, a low or elevated situation, and all the circumstances attending a diversity of geographical position, better than any other of the inhabitants of the globe.

Man, in addition to his animal endowments, is also possessed of mental faculties, by which he reasons and reflects, and language and literature, by which he accumulates and transmits knowledge. The perceptions of the lower animals

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are confined solely to earth,—man can extend his thoughts beyond terrestrial things. He alone has true consciousness of existence, of his relation to a higher Power, and of a moral responsibility for his actions.

> "There wanted yet the master-work, the end
> Of all yet done—a creature who, not prone
> And brute as other creatures, but endued
> With sanctity of reason, might erect
> His stature, and upright with front serene
> Govern the rest; self-knowing and from thence
> Magnanimous to correspond with heaven."—MILTON.

There is such a similarity in the physical structure of all the races of man, and such a general identity in his mental qualities, as leads to the conclusion, on independent grounds, that all mankind are of one species; and thus the historical record of his origin from a single pair, is confirmed. There are no such differences between any of the races of man as those between the wolf and fox, or the lion and tiger. One distinctive mark is that of the colour of the skin; but colour among other animals is no test of a distinction of species. We find a black and a white lamb produced by the same mother, and all varieties in the colour of animals of the same species.

Yet we find that there are several well-marked distinctions among mankind, so as to separate them into varieties or races.

Ethnology is the history of nations or races, and their languages.

From the earliest dawn of history such distinctions have been pointed out, and in some of the most ancient paintings in Egyptian tombs, at least three distinctions of colour are visible—a white race, a reddish or tawny, and a black.

These distinctions of race appear, then, to be so far ancient and permanent, and are confined, on the whole, to particular regions of the globe, though the peculiarities do not depend upon, or at all events do not originate in, climate.

Thus though the influence of a tropical sun in deepening the tint of the skin, may, to a certain extent, be considerable, yet the eastern Asiatics are of the same race, both in the frigid, tem-

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perate, and torrid zones of that region. They do not assume the forms of the tropical Africans. The Esquimaux of the arctic regions, the Ugrians, and Tungusians of the more temperate climates, as well as the Chinese and the Japanese of the tropics, all exhibit the same personal characteristics, and are all nearly of the same tint of skin.

Two races, the Celt and the Saxon, have lived in contiguous countries in Europe for at least 2000 years, yet the dark hue and peculiar features of the Celt remain to this day distinct from the fair and florid Saxon.

Though climate, then, cannot be said to modify man into a peculiar race, yet some races are evidently naturally adapted to particular climates. Thus the negro is physically a tropical being, and the Teutonic race seems to thrive best in a high latitude.

There are three well-marked types or forms among mankind, which may be termed the three primary races, and out of which probably all the other varieties have sprung.

These races are the *Caucasian*, or white; *Mongolian*, or tawny; and *Ethiopian*, or black.

These races are undoubtedly permanent, and have certain great centres where they prevail.

Europe and western Asia is the region of the Caucasian, eastern Asia of the Mongolian, and Africa of the Ethiopian.

The general characteristics of the races are—

The CAUCASIAN has a round, somewhat oval, and symmetrically formed head, an oval face, prominent well-formed features, forehead well developed; skin fair and ruddy, or of various shades of brown; hair on head and chin abundant, soft, and of a fair or a dark colour; iris of the eye blue, hazel, or black; intellect highly developed, as also æsthetic, poetical, and musical talent. Language copious, with numerous inflections. This race excels in science, arts, commerce and general enterprise, and civilisation.

The MONGOLIAN has a square-shaped head, rather angular than rounded, of a heavy form though not large. The cheek-bones are very prominent; nose flat; eyes small, dark, and eyelids drawn up towards the outer angles, giving an oblique form to the eyes; face broad and flattened; skin of a lemon yellow, or olive brown; hair coarse, lank, and black,

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and little or no beard; body square, and stature rather low. The intellect is not of the high order of the Caucasian. The character is shrewd, sagacious, crafty, and insincere. Imagination and taste are deficient. They are imitative and skilful in domestic arts; and a certain stage of civilisation is early acquired; but then it becomes stationary, not progressive. The language is of that peculiar kind called monosyllabic, inartificially constructed, with no inflexions of verbs, and with a limited range of expression. Their religious aspirations are very obtuse, and confined to a materialistic morality, or the vague imaginings of Budhism, or the necromancies of Shamanism. This race is spread over the whole of eastern Asia, from the arctic circle to the equator, and thus it is subjected to the influence of all varieties of climate and local position. The Mongols of north-eastern Asia form the type from which the designation of the race is derived.

ETHIOPIAN or Negro.—The head is narrow, compressed at the sides, and elongated from front to back. The forehead is convex, retreating, and narrow. The cheek-bones project; nose very flat, and broad at the base. The jaws are large, and project very much; mouth large and lips thick. The skin various shades of black; hair crisp, woolly, and curly, but scanty on the chin. The body is strong, muscular, and symmetrical. The intellect is sufficiently acute, but is without depth or comprehensiveness. The negro is very patient of hard and protracted labour under a burning sun, and even in damp and marshy situations where others would sink under disease. His disposition is docile and submissive, honest and cheerful. No negro nation is conspicuous for science, art, or literature, nor for maritime pursuits of any kind. The continent of Africa is the central region of this type, and some of the islands of Polynesia, where a Papuan race, similar to the negro, is found.

From these three types other sub-varieties have arisen, probably from admixture of races; as the Malay, the Ame-

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rican, the Papuans of New Guinea, and the tribes of South Africa, as the Hottentots, Kaffirs, Bosjesmen, who differ from the true negro.

The MALAY races can be traced from the Burman empire through the Malay peninsula, Borneo, Java, Sumatra, eastward to the Polynesian islands. In general features they resemble the Mongolian type, but vary considerably in their stature, colour of skin, and form of head. The character of the true Malay is treacherous, ferocious, implacable; while some of the Polynesian races exhibit a superior mental and moral capacity, and are very susceptible of civilisation.

The AMERICAN RACE is essentially the same both in the north and south of that continent. The general form of the head resembles the Mongolian, but the summit is more rounded and the sides are less angular. Colour of the skin yellowish red and brownish copper hue. Beard scanty.

The Mexicans and Peruvians, at the time of the Spanish conquest, had arrived at a considerable degree of civilisation. They had large cities, and temples, and roads traversing the country. The North Americans were in the rude state of hunters and ferocious warriors. The Patagonians are in the most degenerate state of savage barbarism. There are numerous dialects and languages among the various nations; all, however, appear to have had one common origin.

SECTION XV.—THE CAUCASIAN RACE AND ITS SUB-RACES.

Of the CAUCASIAN type there are several varieties.

The region of the Caucasus, the supposed cradle of man, has afforded the name of this division. The Circassians and Georgians, a fair well formed race, are the models of this type.

The CELTIC RACE (anc. *κελτοι*, *Galatæ*, *Pyreni*), are characterised by a well-formed head, elongated from front to back, and moderate in breadth; face oval; features well de-

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fined and elegantly formed; complexion dark; dark brown or black eyes; black hair turning early gray; form middle size, handsome; feet and hands small. Mental powers quick, active, and energetic, rather than profound. Passions and affections strong. Fond of society, but not forgetful of injuries. Monarchial in their governments. They occupy the southern and insular parts of Europe.

The TEUTONIC, GOTHIC, or SAXON RACE, has the head larger and rounder than the Celtic, and broad but not long; the forehead is broad and massive, especially in the line of the eyebrows; face round and full; complexion fair and ruddy; blue eyes; flaxen, reddish, or auburn hair. Body and limbs large, inclining to fat; feet and hands large and clumsy. Mental powers slow, but accurate and powerful; not brilliant, but deep and penetrating. Character provident, cautious, reserved, but hospitable, sincere, and forgetful of injuries. Fond of independence and self-government. Capable of great and sustained undertakings; skilful seamen; adventurous, bold, and fond of colonising. Excel in science, art, music, poetry, and painting. Central and north-western Europe, Britain, and now, by colonisation, a great part of North America, Australia, parts of India, &c., are the countries of the Teutonic race.

SLAVONIAN RACE (anc. *Thracians* and *Sarmatæ*).—The form of the head and face is more square than oval; cheek-bones prominent; complexion sallow; eyes grey or hazel brown, deeply sunk in the sockets; hair dark brown, hard, and bristly. In stature they are tall, with a short and thick neck, and of great muscular strength. They show considerable mechanical talent, musical powers, and faculty of imitation. They are tenacious of old manners and customs, inclined to be slovenly, and to pay a blind obedience to their rulers. Russia, Poland, and Lithuania, are the countries of the Slavonians.

These three races occupy the greater portion of Europe.

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The Celtic race appears to have come from the eastward, and passed along the shores of the Mediterranean. They were a numerous, and, to a considerable extent, a civilised people, with a hierarchy of Druid priests. Their progress westward appears to have been checked by the Teutonic races from the north of Europe, who, in the course of time, seem to have become the conquerors of the Celts, and, finally, amalgamated with them, as in Belgium, Italy, Britain, Ireland.

The Teutones, under the name of Goths, made repeated irruptions into Italy and Greece, and finally overthrew the Roman empire.

In the second and third centuries of the Christian era, from causes not well known, great and general movements of these northern tribes took place into the south of Europe.

The Teutonic, Celtic, and Slavonic languages are all cognate with the Sanscrit, having their roots in common. The same is the case with the Greek and Latin languages; so that the presumption is, they all originally had one common source. There are two marked divisions of the Teutonic language—the high (central) German—the low Dutch.

The Celtic and Slavonic races adhere to the Romish and Greek churches; the Teutonic races have embraced the religion of the Reformation.

The amalgamation of the Celtic and Saxon races is gradually taking place in Europe by intermarriages; and the physical characteristics of black hair and dark features are, on the whole, superseding the fair complexions and yellow hair of the Teutonic race.

Some obscure traditions and architectural traces of an aboriginal Cyclopean race, inhabiting the shores of the Mediterranean, afford reason to suppose that an early population, perhaps of Tsudic origin, from the north-east of Asia, was scattered over some parts of Europe. The Basques, having a peculiar language, are supposed to be the remnants of an early stock

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from the north-east. An Etruscan race, that once inhabited the southern part of Italy, have long since become extinct.

Great Britain and Ireland appear to have been first peopled by the Celtic race, probably at different times, and from various parts of the adjoining continent of Europe.

There are five sub-divisions of the Celts, marked by different dialects of one common language:—

I. The *Gael* (ancient Caledonians), inhabiting the greater part of the north-west Highlands of Scotland, and the Western Islands. Dialect, the Gaelic.

II. The *Manx*, inhabiting the Isle of Man. Dialect, the Manx.

III. The *Erse*, or *Irish*, inhabiting the greater part of Ireland, with the exception of portions of the north, east, and south-east coasts. Dialect, Erse.

IV. The *Welsh*, inhabiting Wales; but the northern part contains Teutonic blood. Dialect, Welsh.

V. The *Cornish*, inhabiting Cornwall and the Scilly Islands. Their dialect became extinct 150 years ago.

In course of time, Ireland and England received successive colonies of the Teutonic race from Scandinavia, Belgium, Saxony, Denmark, and, lastly, Normans from France, who, however, were originally Scandinavians.

The more unmixed Teutonic races occupy the south-east, eastern, and northern counties of England; while in the west, an admixture of Welsh and Cornish races prevails.

In Scotland, the Saxon, Pictish, and Scandinavian immigrants occupy the valleys along the whole eastern border of the island, while a more or less mixed Saxon race inhabits the central country, and a nearly pure Celtic people occupy the western coasts and adjoining islands. The Orkney and Shetland Islands are almost entirely Scandinavian.

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It is extremely doubtful to what race or modification the term *Pict* belongs, whether to the Saxon (a colony of Atacotti from Ireland), or to the aboriginal Celt.

The INDO-EUROPEAN RACES, besides the Celtic, Teutonic, and Slavonic, include the Circassians, Georgians, Persians, Afghans, Hindoos.

The Persians are the descendants of the ancient Medes, and they retain, in the present day, the national lineaments, as seen depicted on ancient sculptures.

They have handsome features; high foreheads, aquiline noses, black eyes, dark-brown skins, with ruddy cheeks, and black hair, and ample beards.

Unknown to the Greeks of the Homeric age, they appeared about 600 years B. C. as warriors and conquerors, overturning the dynasties of Asia, and subduing the civilised parts of Africa and Europe.

The Hindoos are the present possessors of the Indian peninsula; but most probably they superseded another race, the remnants of which are still discoverable in the Paharias, Ghonds, Koolies, and Vedas, of Hindostan and Ceylon. In general, the Hindoos have the forehead small, and the face thinner and more meagre than Europeans, though the general form of the head and features is allied to that of the Celts. Many of the purer castes, especially in the northern provinces, have an oval face, handsome features, not very dark, with a nearly aquiline nose. Their general expression is mild and timid, and they are rather disposed to melancholy, and to effeminate pleasures.

Herodotus and Dionysius describe the Hindoos, and their divisions into castes, much as they remain at the present day, and as "swart of colour, with dark hair—miners of gold and precious metals—spinners and weavers of cloth —polishers of ivory—pearl-fishers and diamond-searchers."

The ancient and original language of all these tribes is the Sanscrit.

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Brahmanism and Budhism are their ancient religions; but Mohammedanism has been introduced by their Turkish conquerors.

The SYRO-ARABIAN, or SEMITIC RACE, inhabit Syria, Arabia, part of Asia-Minor, and part of North Africa. Their physical organisation is of the most perfect description—with handsome, well-formed bodies—of great muscular activity—skin generally fair—though the Arabs are dark-brown, or of a yellow tinge.

The Semitic race has been celebrated for its intellect, its early acquaintance with literature, for a pure Theism, and as being the peculiar people to whom was committed a revealed religion.

The literature of the Hebrews is unique, from its sacred character, from its adaptation for all times, for all nations, and for every individual of the human race.

To the Arabians, Europe owes the introduction and knowledge of the alphabet, cyphers, algebra, alchemy, astrology, medicine.

The Hebrew language is the original source whence is derived the modern Syriac and Arabic.

SECT. XVI.—THE GEOGRAPHICAL DISTRIBUTION OF THE RACES OF MAN.

The tide of population, flowing out from an ancient and primary centre, has, in the course of ages, peopled every habitable part of the earth.

"Shem, Ham, and Japheth, these are the three sons of Noah; and of them was the whole earth overspread."—GEN. ix. 18, 19.

There has been, from the earliest times, some great centre of civilisation, where the accumulating knowledge and experience of man have been treasured up and transmitted to future generations.

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This great centre has not always been stationary. Ancient Chaldea, Egypt, Palestine, Greece, Rome, Western Europe, have all in their turns been its seat; and the Caucasian race, in some one of its sub-divisions, has been the agent. Religion, science, art, poetry, music, have all been pre-eminently the birth-right of the white races.

The farther mankind have roamed from these centres, the more barbarous they have become.

The discoveries of modern navigation disclose to us man in his lowest physical and mental condition—in Australia, Polynesia, Patagonia.

The population of the Old World (that portion of the earth known to the ancients) has undergone many great changes since the historical epoch.

Assyria, Egypt, Palestine, Asia-Minor, Greece, once the seats of mighty empires and cities, are now comparatively desolate.

The tide of population, for many centuries, has decidedly tended westward; and the spirit of colonisation now bids fair to spread the Teutonic and Celtic races over the whole world.

The amount of the population of ancient times has probably, on the whole, been exaggerated by modern authors, for even that of the greatest cities did not nearly come up to the population of the cities of the present day. An extensive and complete cultivation of the soil is essential to a very dense human population. The conjectured numbers of barbarous and semi-barbarous nations must, on this account, be taken with great allowances.

The total population of Britain, at the time of Cæsar's invasion, has been estimated at only 760,000.

The whole of North America, now occupied by twenty-five millions of Anglo-Saxons, at the time of the first British emigration did not, perhaps, contain three millions of aboriginal Indians.

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Among the great movements of mankind, which have had an influence on the rise and fall of nations, may be mentioned:—

The irruption of Nimrod, continued afterwards by the Babylonians, into Palestine, and the countries allotted to Shem.

The conquest of Egypt by the shepherd-kings (Hyk-sòs.)

The return of the Israelites to Palestine.

The Medo-Persian irruption into Greece.

The Roman conquests of Western Asia, North Africa, and Southern Europe.

The irruption of the Goths and Huns into Italy.

The Arabic conquests in Europe.

The Turkish and Mohammedan conquests in Europe and Western Asia.

The Mongolian and Tartar irruptions into Eastern Asia.

The Crusades.

The Spanish conquests in Central and South America.

The British colonisation of North America.

The British conquests of Hindostan.

The British colonisation of Australasia.

During these successive changes and conquests, it is not to be wondered at that languages have also undergone great mutations. The ancient Greek, Latin, Hebrew, and Coptic languages have ceased to be spoken tongues. The Etruscan is totally lost. The Celtic has been supplanted in many nations, as Spain, Italy, France, by a mixed dialect of modern construction. The Anglo-Saxon has, in Britain, been formed into the English language.

Though a similarity of language is one test of the identity of race, yet it is not invariably so, as an invading race not unfrequently adopts the language of the nation they conquer.

The boundaries and durations of the great empires of the world may be stated as follows:—

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Ancient and Modern Empires.

The Assyrian.—Syria, Chaldea, Media, Armenia, Palestine, Egypt.—Began 2234 A.M., or 1770 B.C.; ended 3466 A.M., or 538 B.C.

Persian.—Boundaries—Asia-Minor on W. to Indus on E.; N. Mt. Caucasus, southern borders of Caspian; N. E. Imaus, S. E. Persian Gulf included; Syria, Egypt, and Libya.—Began 3466 A.M., or 538 B.C.; ended 3674 A.M., or 330 B.C.

Macedonian.—Boundaries—The whole of the Persian, as above, with part of India on the E., to the riv. Hyphasis and Greece on the W.—Began 3674 A.M., or 330 B.C.; ended 3681 A.M., or 323 B.C. Then divided as follows, among four of Alexander's generals:—Cassander—Macedon and Greece; Lysimachus—Thrace and Asia, N. of Hellespont; Ptolemy—Libya, Egypt, and Palestine; Seleucus—the rest of Greece.

Roman.—Bounded on E. by Tigris and Euphrates, to long. 44° E.; the whole of central Europe and Britain; Egypt, Libya, Mauritania, N. Dacia. Began 3250 A.M., or 754 B.C.

Christendom.—Boundaries—At the rise of the Mohammedan religion, the whole Roman empire, as above.

Mohammedan.—Bounded on N.E., by Mongolia; E., the Ganges, and Bay of Bengal; S. E., Malay Peninsula and Archipelago; S., Madagascar, and S. E. Africa, Arabia, Egypt, and N. of Africa, S. of Spain, Sicily, S. of Italy, and E. of Greece.—Began A.D. 622, the year of the Hegira.

The British Empire consists of Great Britain, Ireland, and isles; Heligoland Island, Gibraltar, Malta, Ionian Islands; Hindostan, Aracan, Ceylon, Malacca, Labuan, Prince of Wales' Island; Sincapore, Hong-Kong; Australia, Tasmania, New Zealand, Norfolk Island; Canada, New Brunswick, Nova Scotia, Newfoundland, and North America N. of lat. 49° N.; Bermuda Islands, Honduras; West India Islands; British Guiana; Cape of Good Hope, Sierra Leonè, Fernando Po, St. Helena, Ascension Island, Mauritius.

The present population of the world may be thus stated, according to ethnological distinctions:—

Caucasian,	Teutonic, pure and mixed, Europe and America,	85 to 100	millions.
	Celtic, do. do.	75	do.
	Slavonian, Magyars, &c.,	70 to 80	do.
	Semitic; Persians, Hindoos, &c.	120	do.
Mongolian,		420	do.
Negro and Papuan,		100	do.
Malay and American,		30	do.
		900	millions.

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Table of the Classification and Present Distribution of the Races of Man.

I. Caucasian.

Indo-European.

Europe.

Georgian; Circassian.
Pelasgo-Grecian.
Italia-Tuscan.

Celtic.
- Spain.
- Portugal.
- France.
- Switzerland (part of.)
- Ireland, ½.

Mixed Celt. & T.
- Belgium.
- Great Britain.

Teutonic.
- Holland.
- Switzerland (part of.)
- Germany, N. and S.

Scandinavian.
- Norway.
- Sweden.
- Denmark.
- Iceland.
- Orkney, Faröe.

Slav.
- Russia.
- Poland.
- Lithuania.
- Bohemia.

Mixed Cauc. & M.
- Finns, Lapps, Letts.
- Magyars.
- Turks.
- Basques.

Central Asia.

Persians.
Afghans.
Kurds.
Hindoos.
Cingalese.

Aborigines of Hindostan.

(Mixed?)

Paharias.
Bheels.
Nagas.
Ghonds.
Koolies.
Vedas, Ceylon.
Habbashie, Persia.
Jamaules, Aden.

America.

Anglo-American.
United States, Canada, &c.
Hispano-American.
Mexico.
Peru.
Chili.
Brazil.

Syro-Arabian, or Semitic.

Western Asia.

Chaldeans.
Syrians, or Aramœans.
Hebrews.
Arabs.

Northern Africa.

Mixed Races.

Berbers.
Abyssinians.
Copts.
Nubians.
Shangallas.
Tibboos.

II. Mongolian.

Beardless Races, &c.

Eastern Asia.

Mongols.
Tartars.
Kalmyks.
Chinese.
Indo-Chinese.
Japanese.
Siamese.
Koreans.
Kamchatkans.
Samoides.
Esquimaux.

Mixed Races.

Ugrians.
Ousites.
Turks
Tibetians.

Malayan Races.

Burmese.
Malayese.
Sumatrans.
Javanese.
Phillippines.
Polynesians.
New Zealanders.
Australians.

North America.

Northern Nations.

Athapascas.
Algonquins.
Iroquois.
Cherokees, &c.

Western Nations.

Sioux.
Pawnees.
Blackfeet.
Shoshonees.
Californians.

South America.

Aztecs, Mexico.
Incas, Peru.
Antisians.
Araucanians.
Caribs.
Pchulches, Pampas.
Guarani, Brazil.
Patagonians.

Mixed Races.

Hispano-Americans.

III. Ethiopian.

Negroes, &c.

Africa, W. & Centr.

Guinea Nations.

Felups.
Susus.
Kroos.
Ashantis.
Widah.
Benins.
Guberis.

Senegambian Nations.

Mandingos.
Jolofs.
Felatahs, or Foulahs.

Southern Africa.

(Mixed?)

Loango, Congo, nat.
Kaffirs.
Hottentots.
Bosjesmen.
Ovahs, Madagascar.

Polynesia.

Pelagian or Papuan.
New Guinea.
New Hebrides.
Alfouran.

America.

Negroes of Unit. States.
Guiana.
St. Domingo, &c.

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SECT XVII.—CLASSIFICATION OF ANIMALS.

Considering the great diversity of forms which we find existing in animated nature, giving rise not only to marked divisions of beings, differing widely from each other in appearance and habits, but even in minuter shades, constituting innumerable species, it must be evident that, in order to study or describe them, some arrangement or classification is absolutely necessary.

Nature has so far made this classification; but as, in her scale of being, she does not altogether proceed in a straight line, blending every order, and class, and family by a progressive and imperceptible gradation, neither are her links, or circles of natural groups, of which her chain is made up, always complete, or in exact accordance one with another. It follows, that any arrangement, however philosophical, must be so far imperfect, and that it must partake both of a natural and artificial character.

There are certain leading denominations common to all arrangements:—

DIVISIONS mark out the great leading distinctions of the whole animal kingdom.

CLASSES comprehend groups which have certain characteristics in common.

ORDERS are groups contained within certain classes.

GENERA are families of orders having certain common marks of resemblance.

SUB-GENERA are offsets from families.

SPECIES are certain members of families having an exact resemblance of all their parts, so that any individual of this denomination is a counterpart of another.

Varieties are individuals of a species, slightly differing from the normal type.

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Every animal and plant has two scientific names—the GENERIC and the SPECIFIC—the one pointing out the family, the other the species, of which it is an individual member. Besides these, there is a trivial or local name generally superadded. If the animal is well known, and an inhabitant of a wide range of country, several of these names, both scientific and trivial, are bestowed upon it; hence originate *synonymes*.

Thus FELIS is the generic name of lions, tigers, cats; and *felis leo*, the lion, *felis tigris*, the tiger, point out the species. The GENUS, leo, belongs to the ORDER CARNIVORA, to the CLASS MAMMALIA, and to the great DIVISION VERTEBRATA.

The teacher may accustom his pupils to give the Latin, French, English, and German names to objects of natural history, by writing out on a black board all the names that occur in the lesson for the day. In this way the pupil's acquisition of languages will be extended and kept up, and also his literary progress encouraged, by thus finding his acquirements turned to use.

It will be observed throughout this work, that the scientific names are given in italics, after the English names of objects.

Cuvier, in modern times, was the first naturalist who attempted to give a philosophical arrangement of the animal kingdom, founded on a knowledge of anatomical structure. His classification has formed the basis of all subsequent arrangements; and its general outline is given, with some slight modifications, in the following Table.

References to this Table are frequently made in the preceding pages; and, indeed, an intimate acquaintance with it is necessary, in order to understand any modern work which treats of zoology.

It will be no difficult matter to collect a sufficient number of specimens to illustrate this Table. In the class Mammalia, the skulls alone, with the teeth, afford the chief characteristics of the families. The skins of birds are easily procurable, and insects and shells are everywhere abundant.

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I. DIVISION VERTEBRATA, *with a skeleton of Bones, and Vertebral Column or Spine.*

Mammalia, with Mammæ, and producing living young.

- *Bimana*, two-handed—man.
- *Quadrumana*, four-handed—orang-outang, monkeys.
- *Carnaria*,
  - *Cheiroptera*, wing-handed—bats.
  - *Insectivora*, insect-eaters—mole, hedge-hog.
  - *Carnivora*, flesh-eaters—dog, lion, bear.
  - *Amphibia*, living partly on land, and partly in the ocean—seal, morse.
- *Marsupialia*, pouched—opossum, kangaroo.
- *Rodentia*, gnawers—squirrel, mouse, hare.
- *Edentata*, toothless—sloth, ant-eater.
- *Pachydermata*, thick-skinned—elephant, horse, tapir.
- *Ruminantia*, ruminants—camel, ox, deer, sheep, goat.
- *Cetacea*—oceanic-whale, dolphin, porpoise, narwal.

Aves, Birds, Bipeds, oviparous.

- *Rapaces*, birds of prey—eagle, condor, hawk, owl.
- *Passerinæ*, three families—thrush, swallow, crow.
- *Scansores*, climbers—parrot, cuckoo, woodpecker.
- *Gallinaceæ*, poultry—cock, turkey, partridge.
- *Grallatores*, waders—stork, heron, plover, snipe.
- *Palmipedes*, swimmers—swan, goose, duck, gull.

Reptilia, Reptiles, cold-blooded.

- *Chelonia*, shielded—tortoise, turtle.
- *Sauria*, lizards—crocodile, chamelion, lizard.
- *Ophidia*, serpents—boa, viper, coluber.
- *Batrachia*, frogs—frog, toad, siren.

Pisces, Fishes, Aquatic, with gills.

- *Acanthopterygii*, spiney fins—perch, mackerel, sturgeon, mullet.
- *Malacopterygii*, Soft-Finned,
  - *Abdominals*—salmon, trout, carp, pike.
  - *Subrachiata*—cod, haddock, plaice, flounder.
  - *Apodes*, eel, conger, gymnotus.
- *Lophobranchii*, tufted gills—pegasus, hippocampus.
- *Plectognathi*, sutured cheeks—sun-fish, porcupine-fish.
- *Chondropterygii*, Cartilaginous,
  - With free gills—sturgeon, chimera spatula.
  - With fixed branchiæ—shark, skate, lamprey.

Agassiz' Orders of Fishes.

- *Ganoides*, enamelled angular scales.
- *Placoides*, shagreened scales, including cartilaginous fishes.
- *Ctenoides*, toothed scales—perch, mackerel, sturgeon.
- *Cycloides*, smooth scales, margined—salmon, cod, haddock.

II. DIVISION MOLLUSCA—*Soft-bodied Animals, mostly Shell-covered and Aquatic.*

Cephalopoda, arms about the mouth—cuttle, nautilus.
Pteropoda, wing-footed—clio, hyalea.
Gasteropoda, belly-creepers, univalves—snail, limpet.

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ACEPHALA, with no distinct head, bivalves—oyster, muscle.
BRACHIOPODA, arm-footed—univalves—ligula terebratula.

III. DIVISION ARTICULATA, *with Jointed Bodies.*

ANNULATA, Ringed.
- *Tubicola*, tube-covered—serpula, terebella.
- *Dorsibranchiata*, gills on the back—nereis, aphrodita.
- *Abranchiata*, without gills—earth-worm, leech.

CRUSTACEA.
- *Malacostraca*, with soft shells—crab, lobster, hermit-crab, land-crab.
- *Entomostraca*, with thin shells—monoculus, extinct trilobites.

CIRRHOPODA, brush-footed—barnacle, balanus.—(Removed from Division II. of Cuvier.)

ARACHNIDES, Spiders.
- *Pulmonaria*, with lungs—spider, mygale.
- *Trachearia*, with spiracles—tarantula, scorpion, mite.

INSECTA, Insects.
- *Myriopoda*, many-footed—centipede, julus, scolopendron.
- *Thysanoura*, with fringed tail, wingless—lepisma, or wood-louse, podura.
- *Parasita*, wingless, live on other animals—louse.
- *Suctoria*, wingless, with proboscis—flea.
- *Coleoptera*, hard outer wings, with a pair below—beetles.
- *Orthoptera*, straight long wings—grass-hopper, locust, earwig.
- *Hemiptera*, half-membranous wings—aphis, bug.
- *Neuroptera*, four net-work wings—dragon-fly, ephemera.
- *Hymenoptera*, four membranous wings—bee, ant, ichneumon-fly, cynips.
- *Lepidoptera*, scaly-winged—butterfly, moth.
- *Rhipiptera*, fan-winged—stylops, xenos.
- *Diptera*, with two membraneous wings—fly, gnat.

IV. DIVISION RADIATA, *with a Circular Radiating Nervous System, and* ZOOPHYTA, *or Plant-like Animals.*

ECHINODERMATA, Spine-skinned.
- *Pedicellata*, with numerous spines—star-fish, sea-urchin, spatangus, encrinite.
- *Apoda*, without spines—siphunculus, lithodermis.

ENTOZOA, Intestinal Worms.
- *Nematoidea*, thread-like, with distinct intestines—ascaris, guinea-worm.
- *Parenchymata*, a cellular sac—hydatid cysticercus, liver-fluke, tape-worm.

ACALEPHA, That sting like Nettles.
- *Simplicia*—medusa.
- *Hydrostatica*—physalia.

POLYPI, Many-footed.
- *Carnosi*, fleshy—actinia.
- *Gelatinosi*, gelatinous—hydra, vorticella.
- *Coralliferi*, with coral houses—tubipore, sertularia, alcyonium.

INFUSORIA, Animalcules.
- *Rotifera*, wheel-animal—hydatina.
- *Polygastrica*, many stomached—monad, volvox.

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GLOSSARY.

Abdomen, The lower part of the body
Absorb, Absorption, The minute mouths of the vessels of the skin, and other parts of the body, have the power of taking up or absorbing fluids, air, &c.
Actinism, The chemical action of the sun's rays
Albumen, Animal jelly, as the white of egg
Algæ, Marine plants
Alimentary, Serving as food, belonging to food
Amphibious, Animals which live both in the water and on land
Annulated, Ringed
Annular, Consisting of rings
Antennæ, Two slender bodies (organs of touch) placed on the heads of insects and other animals
Articulata, Those animals having a jointed structure, but no proper bones
Articulations, Junctures or joinings
Aurelia, A pupa, the second state of an insect
Bifurcated, Divided into two branches
Bimana, Two-handed.
Branchiæ, Gills of fishes and reptiles
Byssus, A beard, common in muscles, pinnæ, &c.
Calcareous, Composed of lime
Canine teeth, The sharp pointed teeth on each side of the four cutting central teeth of animals
Carbonic Acid, The gas which escapes from beer or soda water; absorbed by plants, and expired by animals
Carinated, Keeled
Carnivora, Flesh-devouring animals
Carpus, Bones of the hand
Cartilage, Gristle
Caseine, A nutritive substance found in beans, peas, and other vegetables
Caudal, Relating to the tail
Cere, A skin which covers the base of the bills of some birds
Cerealia, Bread-plants
Chyme, The pulpy fluid when first digested
Chyle, The digested fluid after an admixture of bile
Cilia, Minute hairs of animalcules, &c. which cause currents in water.
Ciliated, Edged with parallel hairs, bristles, or appendages, like the eyelids
Cirri, Tendrils
Cirrous, Like a tendril
Class, A term designating one of the principal divisions of the animal kingdom, including orders, genera, and species
Clavicle, The collar bone
Cocoon, The nest which caterpillars spin for themselves before their transformation into the pupa state
Coriaceous, Like leather
Cotyledon, Seed-lobe; the mealy portions of seeds, as in wheat, and the two halves of a bean
Crustaceous, Consisting of a crust composed of carbonate and phosphate of lime, and animal matter
Cryptogamic, Plants without blossoms, as mosses, ferns
Cutis, The under skin
Digestion, The process by which food is converted into nourishment for the body
Dorsal, Relating to the back
Echinated, Bristled like a hog, set with spines
Elongated, Lengthened, drawn out
Elytra, Hard membranous substances covering the wings of various insects, such as beetles, &c.
Enamel, The hard outer covering of the teeth
Epidermis, The outer or scarf-skin
Ethnology, The history of nations and races of man
Exude, To issue out
Farina, starch; a fine scaly substance, covering the wings of insects

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Filament, A small thread
Fluviatile, Of or belonging to rivers
Foliated, Leaved
Fourchette, A fork
Fuci, A class of sea-weeds
Fungi, Mushrooms
Furcated, Branched
Ganglion, A knotted nervous cord
Gelatine, Viscous, stiff, cohesive matter, a jelly extracted from animal substances by solution in water, but not in alcohol
Gemmiparous, Animals that produce young by buds or slips from the body
Genus, plural *Genera*, a family or kind of animals having a general resemblance to each other, but containing different species
Gemmule, A leaf-bud
Gills, A series of flaps or thin folds on each side of the head of fishes, and some other animals, through which water constantly passes; the air which it contains being absorbed or taken into their blood
Gizzard, The strong muscular stomach of birds
Gland, A knot of vessels like an acorn, secreting organs
Gluten, A tough gluey matter of flour, meal, &c.
Granivorous, Grain-feeding animals
Heart, A strong, hollow, muscular substance, which circulates the blood through the blood-vessels of the body
Herbivora, Those animals which feed on grasses and herbs
Hybernation, A state of winter sleep and torpidity
Imago, An insect when it has become a winged fly
Incisory teeth, The front cutting teeth in the upper and under jaws of quadrupeds
Infusoria, Animals found in infusions of vegetables and other liquids
Insectivora, Animals that feed on insects
Instinct, The power which guides animals in their various operations
Intercostal, Placed between the ribs
Intestinal, Belonging to the bowels
Intestinal worms, entozoa, Animals living in the intestines of other larger beings
Iridescent, Shining with changeable colours.
Iris, the inner curtain of the eye, variously coloured
Irritability, A contracting of organised fibres on the application of any stimulus
Lachrymal, Of, or belonging to, tears
Lacteals, Vessels in the intestines that convey the chyle
Lamellar, Consisting of films or plates.
Laminæ, Thin plates laid one above another
Larva, Grub, or worm, the first stage of an insect before it becomes a fly
Ligament, A solid body softer than cartillage, but harder than a membrane, which fastens the bones and articulates them together for motion; in bivalve shells, the substance which connects the valves
Linear, Composed of lines
Littoral, Of, or belonging to, the shore
Lungs, Substances consisting of numberless cells, through which the air is breathed that contributes to the life of the body
Mammæ, The breasts or teats of animals
Mammalia, Those animals which have teats, and which suckle their young with milk
Mandibles, The upper and under chaps of a bird's bill, or jaws of an insect
Masticate, To chew the food
Maxillæ, Or jaws
Migration, The flight of birds from one country to another at certain regular periods of the year
Mollusca, Those animals having a fleshy body and no bones
Mucus, A slimy secretion
Multilocular, Many-chambered, consisting of several divisions
Muscles, The fleshy substance on the bones of animals by which they move their limbs and bodies
Nerves, Small white cords proceeding from the brain, and going to every part of the body, by which sensation is communicated
Nocturnal, Night-feeding animals
Nympha, Pups, or chrysalis, the second stage of insect life
Œsophagus, The tube leading from the mouth to the stomach
Operculum, The gill-cover of fishes; a lid by which some of the univalve and multivalve shells are closed
Order, A term in zoology which includes genera and species
Organism, Vegetable or animal structure

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Organised, Bodies having vessels and parts necessary for life
Osseous, Of a bony substance
Ovary, The organ which contains eggs
Oviparous, Animals that produce eggs
Ovipositor, An instrument by which insects deposit their eggs
Ovoviviparous, Animals which produce eggs containing living young
Ovum, an egg; plural *ova*
Oxygen, Vital air, one of the gases of the atmosphere
Pachydermata, Animals having thick skins
Palpi, Projections from the lower jaws of insects
Palmated, Webbed as in the feet of some water-birds
Papillæ, Small dots or pimples
Parasitical, Living on some other body
Pectinated, Resembling the teeth of a comb
Pectoral, relating to the breast
Phosphorescent, Emitting light in the dark
Polype—pl. polypes, with *e* mute in both — many-footed; a genus of simple plant-like animals
Prehensile, That can take hold of.
Proboscis, A moveable tube attached to the head of several animals, particularly insects
Progression, The act of walking or moving
Pupa, or nympha, The second stage of insect life
Quadrumana, Having four hands
Quadruped, Having four feet
Radiated, Rayed, furnished with rays
Reptile, A name applied to the class of serpents, frogs, tortoises, &c.
Rete mucosum, The mucous network forming the base of the outer skin, and which is black in the negro
Retractile, Capable of being drawn back
Rodentia, Animals that gnaw with the foreteeth
Ruminantia, Animals which chew the cud
Sac, A small bag or pouch
Secretion, The production of animal matters by vessels and glands
Serrated, Like the teeth of a saw
Setaceous, Bristly, covered with bristles
Skeleton, A frame of bones
Species, Belonging to the same genus or family, but having distinct characters
Spiracles, Air-tubes leading to the branchiæ of insects
Spine, The backbone
Spinous, Having spines like a hedgehog
Stellated, Starred, consisting of star-like figures
Stimulus, Anything that excites or acts on the animal frame; plural *stimuli*
Striated, Scored or covered with fine thread-like lines
Tarsus, the foot bones
Teats, The nipples of animals which suckle their young
Tentacula, Feelers or arms
Testaceous, Consisting of carbonate of lime and animal matter, as in the shells of molluscous animals
Tissue, A thin membrane or web
Thoraæ, The chest or upper part of the body
Torpidity, A state of sleep that animals fall into during winter, in which they neither eat nor move, nor have the usual warmth of body
Trachea, The windpipe leading to the lungs
Turbinated, Shaped like a top or pear
Umbo, In bivalve shells the round part which forms the hinge
Unorganised, Matter without any structure necessary for carrying on life
Variety, Is when one of a species differs in some degree from the normal type
Vascular, Consisting of vessels
Ventral, belonging to the belly
Vertebræ, The bones which compose the spine or backbone
Vertebrata, Those animals having a spine or series of small bones composing the back
Vertebrated, Provided with vertebræ
Villose, } Downy
Villous, }
Viscera, The contents of the internal cavities, as the lungs, intestines, &c.
Viviparous, Animals which bring forth their young alive
Zoology (ζῶον and λογος), a discourse on animals

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